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Combined effects of natural additives and modified atmosphere on quality of fresh cut peaches

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ABSTRACT

The aim of this study was to evaluate the combined use of natural additives and modified atmosphere on the physicochemical and microbiological characteristics of fresh cut peaches. The minimal processing consisted of washing, peeling and sanitizing. The slices were immersed into the following treatment solutions: distilled water control (T1, control); 2% $CaCl_2$ (T2); 2% ascorbic acid (T3); 2% citric acid (T4); 1% $CaCl_2$ + 1% ascorbic acid + 1% citric acid (T5); 2% $CaCl_2$ + 2% ascorbic acid + 2% citric acid (T6). Peaches slices were placed on polyethylene trays, covered by a polyethylene film with modified atmosphere of 2 % O_2, 5% CO_2 and 93 % N_2, and kept in cold storage at 5 °C ± 2 °C for nine days. On days 0, 5, 7 and 9, the following variables were analyzed: total soluble solids, total titratable acidity, pH, total sugar, firmness, counts of mesophiles, heat-tolerant coliforms (45 °C), yeast and mold counting, and sensory analysis of the attributes appearance, color, flavor, texture and overall acceptability. The T5 treatment combined with the use of modified atmosphere demonstrated best qualitative and microbiological characteristics for fresh cut peaches during nine days of storage.

KEYWORDS: Fresh cut, *Prunus persica*, Natural additives, Modified atmosphere.

INTRODUCTION

Consumer demand for fresh-cut fruits and vegetables has increased because of consumers' fast-paced lifestyles. Moreover, different organizations (WHO, FAO, USDA, EFSA) recommend the increase in fruit and vegetable consumption to reduce the risk of cardiovascular diseases and cancer.

Fresh cut peaches are a relevant option to improve the consumption of fruits since this fruit has considerable amounts of carotenoids (β-Carotene, Zeaxanthin, β-Cryptoxanthin), phenolic compounds (catechin, protocatechuic acid, neo-cholorogenic acid, cholorogenic acid) and ascorbic acid (LIU; CAO; JIANG, 2015; SAINI; NILE; PARK, 2015). However, for fresh cut product acceptance by consumers, sensory and nutritional quality must be maintained, as well as food security.

Mechanical operations of fresh-cut fruit such as peeling, removing parts, cutting, washing, disinfecting, rinsing, draining, drying and packaging limit the shelf life of products. These procedures lead to cell rupture, activating the enzymatic process, as well as potential microbiological contamination due to peeling (ARTÉS; GÓMEZ; ARTÉS-HÉRNANDEZ, 2007).

Consumers are becoming more aware of the limitations of commonly sanitizing techniques and are looking for safe food products that suffer minimal processing, with high quality retention. To satisfy these requirements, chemical agents considered GRAS (generally recognized as safe) have been studied to increase the quality and shelf life of fresh-cut fruit. Ascorbic acid, citric acid and calcium chloride may be used alone or in combination in various products, such as pears (GORNY et al., 2002), bananas (VILAS-BOAS; KADER, 2006), bananas' Apple ' (MELO; VILAS BOAS, 2006), melon (OMS-OLIU; FORTUNY; MARTIN-BELLOSO, 2007) and fig fruit (IRFAN et al., 2013)

Ascorbic acid (AA) has a direct impact on the oxidative stability of fruits (LURIE, 2003), preventing enzymatic browning by polyphenol oxidases and peroxidases action (PINELLI, 2004) and thus becoming a quality indicator for fresh-cut fruits and vegetables. Calcium chloride ($CaCl_2$) has been used as a preservative and firming agent in fresh-cut fruit and vegetables (MARTIN-DIANA et al., 2007). Firmness and resistance to softening, resulting from addition of Ca, have been attributed to the stabilization of membrane systems and formation of Ca pectate, which increases rigidity of the middle lamella and cell walls, leading to increased resistance to PG activity and to improved turgor pressure (MIGNANI et al., 1995).

Usually reduced O_2 and increased CO_2 concentration are used to enhance the shelf life of fruit and vegetables. Hence, modified atmosphere packaging (MAP) successfully prolongs the postharvest shelf-life of whole and pre-cut commodities by reducing their respiration rate, minimizing metabolic activity, delaying enzymatic browning and retaining visual appearance (CUI et al., 2009).

The use of modified atmosphere associated with chemical treatments in fresh-cut products has been reported as an effective way to

delay the detrimental phenomena that occurs during fresh-cut processing (OMS-OLIU; FORTUNY; MARTIN-BELLOSO, 2007. ALBERTINE et. al., 2016). Thus the objective of the present work was to evaluate the use of natural additives with modified atmosphere packaging on physicochemical characteristics, sensory quality and microbiological quality of fresh cut peaches.

MATERIAL AND METHODS

PREPARATION OF PEACHES SAMPLES

Peach (*Prunus persica*, cv. 'El Dorado') fruits were obtained from a producer associated with CEASA-RS (Central Supply Center, RS, Brazil) during February 2011. After selection for uniformity of size and color and absence of injury and infections, fruits were submitted to pre-washing with potable water and cold storage at 5 °C, for 24 hours, to reduce the internal temperature until the moment of cutting.

TREATMENT PROCEDURE

About 15 kg of fruits were previously immersed in a 2 mM (150 $mg.L^{-1}$) sodium hypochlorite solution at 5 °C for surface disinfection for 5 minutes and then peeled and sliced. After that, longitudinal cuts were made to obtain four segments per fruit. Subsequently fruits slices were dipped in a 0.3 mM (20 $mg.L^{-1}$) sodium hypochlorite solution at 5 °C for 1 minute and finally washed with sterile water. Peaches slices were then immersed for 3 minutes in the following treatment solutions: T1 (control, immersion in distilled water); T2 (2% calcium chloride); T3 (2% ascorbic acid); T4 (2% citric acid); T5 (1% calcium chloride + 1% ascorbic acid + 1% citric acid); T6 (2% calcium chloride + 2% ascorbic acid + 2% citric acid). Subsequently, peach slices were allowed to drain for a further 3 min and after packed and sealed in 25µm polypropylene bags with oxygen (O_2) permeability of 7000cm^3 m^{-2} d^{-1}, (CO_2) permeability of 20000cm^3 m^{-2} d^{-1} and water vapor permeability of 1g m^{-2} d^{-1}. The atmosphere inside the packages was modified and thermo sealed to an initial concentration of 2kPa O_2, 5kPa CO_2 and nitrogen as balanced with a Fastvac F200 Flash thermo sealer. Samples were stored in a refrigerated displaying cabinet simulating retail settings. Quality evaluations were carried out on the day of experiment set up and after 5, 7 or 9 more days of storage at 5°C and 12-hour light exposure. Each treatment consisted of three replicates, with each replicate consisting of four peach slices (80g).

PHYSICO-CHEMICAL ANALYSIS

During storage period, quality evaluation of fresh cut peaches was evaluated by the following physico-chemical analyses: total sugars expressed in % sucrose, total titratable acidity (TTA) expressed as % citric

acid, pH, total soluble solids (TSS) expressed in ° Brix, according to the AOAC method (1997), firmness through the use of manual penetrometer model BISHOP ST-011, expressed in kgf.

MICROBIOLOGICAL ANALYSIS

The microbiological quality was evaluated by analyzing aerobic plate count of mesophile microorganisms, heat-tolerant coliforms (45 °C) by the technique of the Most Probable Number ($MPN.g^{-1}$) and yeast and molds counts ($UFC.g^{-1}$) according to the methods described in American Public Health Association (APHA, 2001).

SENSORY ANALYSIS

Sensory analysis was performed with thirty volunteers not trained from the ICTA and students from the Federal University of Rio Grande do Sul (UFRGS)/ Brazil that evaluated the appearance, color, flavor, texture and overall acceptance of the product using a 5-point hedonic scale (DUTCOSKY, 2007). The study was approved by the University Ethical Committee (Protocol nº:12059), and the participants were informed of all of the details of the study.

STATISTICAL ANALYSIS

Three replicates of each treatment and for each analysis period were prepared and the average of each day/treatment/variable were analyzed in completely randomized blocks using the software Statistica 12.0 at a significance level of 0.05 (STATSOFT Inc.).

RESULTS AND DISCUSSION

PHYSICO-CHEMICAL ANALYSIS

The results of total soluble solids (TSS), pH, sugars and acidity (TTA) of fresh-cut peaches slices as affected by different treatments are shown in the Table 1. The TSS ranged from 9 to 11.2 °Brix (day-0) and decreased at the end of storage. As compared to the control, all treatments had significant ($p \leq 0.05$) effect on TSS content. TSS of the control (T1), T6 and T2 showed significant decreases along storage time. This drop probably occurred due to utilization of TSS in the respiratory processes. At the end of storage, on day-9 the treatment that provided the highest level of TSS in peaches was T4. Vilas Boas et al. (2004) also observed in fresh-cut 'Tommy Atkins' mangoes treated with citric acid higher content of TSS.

The pH and TTA showed different behaviors. While pH increased at the end of storage, the TTA decreased, both significantly at 95 % confidence level ($p \leq 0.05$). A significantly higher TTA was found in samples

treated with T5 than that the other treatments. This suggests that the T5 provide a better maintenance of peach acidity and probably a lower utilization of organic acids in the respiratory process. Total sugars varied significantly among treatments and during evaluation days (Table 1). It was observed that treatment T5 led to lower values of total sugars.

Peach slice firmness was affected by the five treatments used (Table 1). On day-0, the T4 had the highest firmness value of 4.3 kgf, followed by T1, T6, T2, T5, T3 with 4.**1**, 3.8, 3.5, 3.3, and 3.1 kgf respectively (Table 1).

During 9-day storage, the untreated peach slices and the treatment T3 experienced highest loss of firmness whereas, the treatments T2 and T5 exhibited minimum firmness changes, possibly due to action of $CaCl_2$. Miguel, Dias and Spoto (2007) studied fresh-cut watermelon and found a significant difference between the texture of watermelon slices treated with 1 % calcium chloride and those that were not treated.

According to Salunke, Bolin and Reddy, 1991 calcium creates covalent linkages between pectin molecules in the cell wall and the middle lamella and this limits the action of enzymes responsible for the loss of texture and firmness. However the combination of 2% calcium chloride + 2% citric acid + 2% ascorbic acid (T6) was not effective for maintenance of texture, possibly due to a negative interaction between the highest concentrations additives acids and the highest concentration calcium chloride.

MICROBIOLOGICAL ANALYSIS

Fresh-cut fruits are a fertile environment for microorganisms to grow due to the high amount of moisture and sugar present on the fruit surface. Consequently, the study of the development of microbial growth is required to ensure microbial safety of those products (ROJAS-GRAÜ et al., 2007).

Figure 1 shows the total count of mesophilic cells on fresh cut peaches, during cold storage at 5°C. On day 0, peaches treated with natural additives and modified atmosphere showed mesophilic counts below detection limits (1 log CFU g^{-1}) for five treatments (T1, T2, T3, T5 and T6) and the treatment T4 presented count of 1.7 log CFU g^{-1}. However, on day 7 there were significantly higher counts of mesophilic cells on peaches treated with the five treatments, except for T5. On day 9, the T2 (only 2 % calcium chloride) showed the highest microbial count (7.8 log CFU g^{-1}) and T5 the lowest count (2.8 log CFU g^{-1}). These results suggest that calcium salt better inhibits the bacterial growth when associated with organic acid. On evaluating the effect of calcium chloride on the shelf life of minimally processed 'yellow' melon, PERONI (2002) showed that after 10 days of storage, a concentration of 0.9% calcium chloride promoted multiplication of the total count of mesophilic cells. The combination of organic acids in T5 and modified atmosphere provided lower mesophilic counts. Our results were similar to those reported by Oms-Oliu, Fortuny and Martin-Belloso (2007) that evaluated the microbial stability of fresh-cut "Piel de sapo" melon preserved with 1 % L-ascorbic acid and 0.5 % calcium chloride

with modified atmosphere, after 14 days of storage at 5 °C. These authors found that this minimal processing also inhibited microbiological growth, resulting in lower values of bacterial counts. The results of the present study were consistent with those demonstrated by Badosa *et al*. (2008) who analyzed 445 commercially available fruits in Spain. These researchers showed aerobic counts on fruits ranging from <1 to 8 log CFU g^{-1}, most of them falling between 3 and 4 log CFU g^{-1}.

Table 1. Effect of different treatments on total soluble solids, pH, total titratable acidity, total sugar and firmness of the fresh cut peaches with CA (2kPa O_2, 5kPa CO_2, 93kPa N_2) during storage at 5 °C ± 2 °C.

Parameter	Treatments	0	5	7	9
Total Soluble Solids (°Brix)	Control (T1)	9.0 ^{Ca}	9.0 ^{Aa}	8.6 ^{Bb}	8.2 ^{CDc}
	T2	10.1 ^{Ba}	9.6 ^{Aa}	8.7 ^{Bb}	8.5 ^{Cb}
	T3	10.1 ^{Ba}	9.1 ^{Ab}	9.6 ^{Aab}	9.4 ^{Aab}
	T4	10.0 ^{Ba}	9.6 ^{Aab}	9.6 ^{Aab}	9.7 ^{Aa}
	T5	10.1 ^{Ba}	9.1 ^{Ab}	9.6 ^{Aab}	9.2 ^{Bb}
	T6	11.2 ^{Aa}	9.1 ^{Ab}	9.0 ^{Bb}	7.9 ^{Dc}
pH	Control (T1)	3.9 ^{Ab}	3.9 ^{ABb}	3.8 ^{Ab}	4.3 ^{Aa}
	T2	3.4 ^{BCb}	3.8 ^{CDb}	3.9 ^{Ab}	4.0 ^{Ba}
	T3	3.9 ^{ABb}	3.9 ^{Ab}	3.9 ^{Ab}	4.3 ^{Aa}
	T4	3.9 ^{Ab}	3.8 ^{BCb}	3.7 ^{Bc}	4.1 ^{Ba}
	T5	3.6 ^{Db}	3.8 ^{Bda}	3.8 ^{Aa}	3.8 ^{Da}
	T6	3.7 ^{Cc}	3.9 ^{Aa}	3.8 ^{Ab}	3.9 ^{Ca}
Total Titratable Acidity (% citric acid)	Control (T1)	0.608 ^{Da}	0.563 ^{Cb}	0.505 ^{Dc}	0.409 ^{Fd}
	T2	0.608 ^{Da}	0.588 ^{Ab}	0.537 ^{Cc}	0.524 ^{Bd}
	T3	0.544 ^{Ea}	0.486 ^{Eb}	0.467 ^{Ec}	0.422 ^{Ed}
	T4	0.672 ^{Ca}	0.569 ^{Bb}	0.557 ^{Bc}	0.499 ^{Cd}
	T5	0.787 ^{Aa}	0.569 ^{Bd}	0.582 ^{Ab}	0.627 ^{Ac}
	T6	0.736 ^{Ba}	0.512 ^{Db}	0.505 ^{Dc}	0.480 ^{Dd}
Total Sugar (% sucrose)	Control (T1)	6.1 ^{Fd}	9.5 ^{Ca}	8.0 ^{Ec}	8.4 ^{Bb}
	T2	6.8 ^{Ed}	9.1 ^{Db}	9.4 ^{Ba}	8.7 ^{Ac}
	T3	8.8 ^{Ac}	9.7 ^{Bb}	10.4 ^{Aa}	7.6 ^{Cd}
	T4	8.1 ^{Bc}	8.5 ^{Eb}	9.2 ^{Ca}	7.7 ^{Cd}
	T5	7.9 ^{Dc}	10.1 ^{Aa}	8.1 ^{Db}	7.5 ^{Dd}
	T6	8.0 ^{Cc}	8.5 ^{Eb}	7.9 ^{Ec}	8.8 ^{Aa}
Firmness (kgf)	Control (T1)	4.1 ^{Ba}	3.6 ^{Bb}	2.5 ^{Cb}	1.6 ^{Dc}
	T2	3.5 ^{Db}	3.9 ^{Aa}	3.7 ^{Ab}	3.1 ^{Bc}
	T3	3.1 ^{Fa}	2.5 ^{Cb}	2.6 ^{Cb}	1.6 ^{Dc}
	T4	4.3 ^{Aa}	1.9 ^{Dd}	2.6 ^{Cb}	2.4 ^{Cc}
	T5	3.3 ^{Ec}	3.9 ^{Aa}	3.1 ^{Bd}	3.7 ^{Ab}
	T6	3.8 ^{Ca}	2.7 ^{Cb}	2.7 ^{Cb}	2.4 ^{Cc}

NOTE: Different letters in column (A, B, C) and in rows (a, b, c) indicate significant differences between treatments, according to Tukey's test with a P value of 0.05.

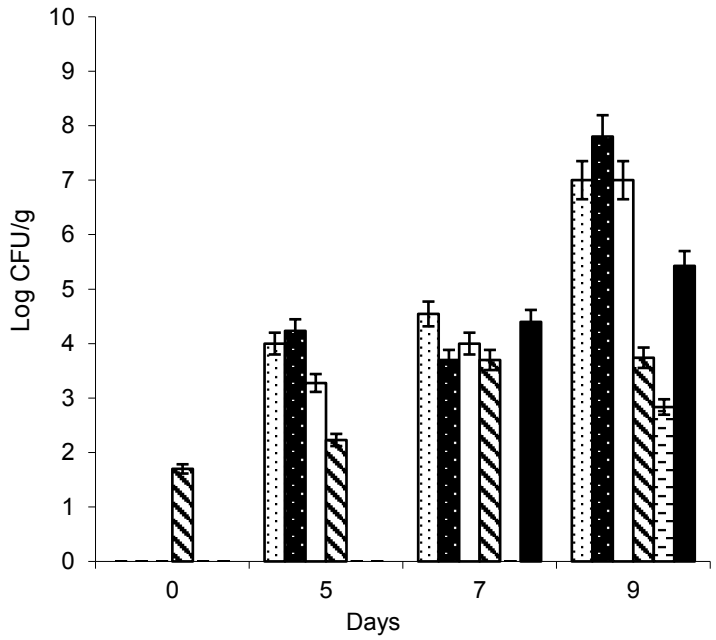

Figure 1. Total count of mesophilic cells in fresh cut peaches with natural additives combined with modified atmosphere (2kPa O_2, 5kPa CO_2, 93kPa N_2) stored at 5 °C ± 2 °C for up to 9 days. Treatments: ( ) – T1 (Control); ( ) – T2; ( ) – T3; ( ) – T4; ( ) – T5; ( ) – T6.

In Brazil, there is no specific legislation for the total counts of mesophilic cells permitted on fresh cut fruits and vegetables, but some standards or recommendations can be used for comparison. The regulations of France and Germany established that ready to eat vegetables must have the maximum of 7.7 log CFU g^{-1} of total count of aerobic mesophiles (LEGNANI; LEONI, 2004). In this study, the treatments T2 on the ninth day showed total count of aerobic mesophilic cells above 7.7 log CFU g-1, which is not in accordance with the recommendation of France and Germany.

The same trends observed for mesophilic microorganisms were observed for yeast and mold counts on peaches (Figure 2) on day 0. The yeast and mold counts varying from < 10 CFU g^{-1} to 10^5 CFU g^{-1} at the period of storage. On day 9 the treatment T3 (2% ascorbic acid) showed the best results to yeasts and molds with counts of 2.83 log CFU g^{-1} and the treatment T4 showed the worst results (5.3 log CFU g^{-1}). The T2 showed counts of 4.17 log CFU g^{-1} on day 9. Evaluating the effect of 2% calcium chloride on the shelf-life of fig fruit, Irfan *et al*. (2013) showed that after 14 days of storage at 1 °C ± 0.5 °C, fig fruits presented 3.17 log CFU g^{-1} of yeasts and molds.

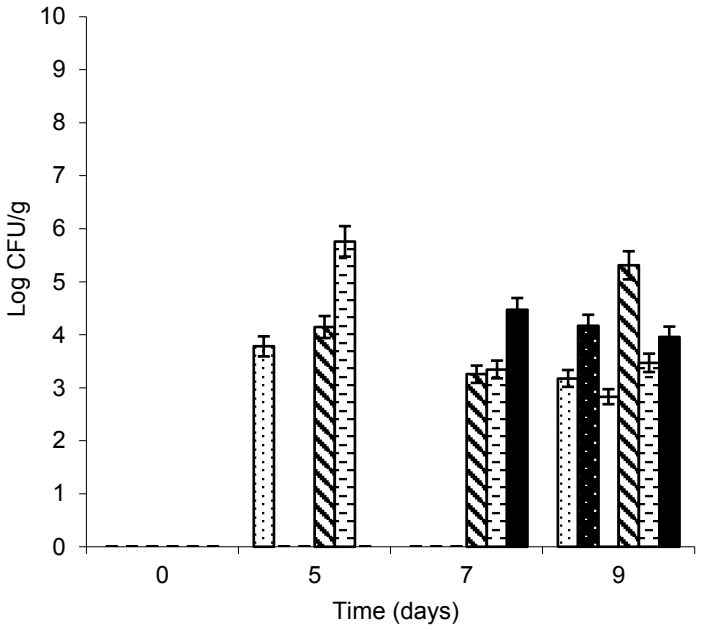

Figure 2. Yeast and mold counts in fresh cut peaches with natural additives combined with modified atmosphere (2kPa O_2, 5kPa CO_2, 93kPa N_2) stored at 5 °C ± 2 °C for up to 9 days. Treatments: (⬚) – T1 (Control); (⬛) – T2; (☐) – T3; (▨) – T4; (⬚) – T5; (■) – T6.

The ranges for yeast and mold counts in fresh-cut fruit commercialized in Spain during the period 2005–2006 were 1.7–4.9 log10 CFU g^{-1} (ABADIAS *et al.*, 2008). Tournas, Heeres and Burgess (2006) found higher yeast and mold counts in types of fruit salad (cantaloupe, honeydew melon, citrus fruit, pineapple, strawberry, watermelon and mixtures of these fruits) ranging from < 2.0 to 9.72 log10 CFU g^{-1}.

On studying the microbiological quality of minimally processed fruits commercialized in the city of Fortaleza, Brazil, Pinheiro *et al.* (2005) found yeast and mold counts varying from <10 CFU g^{-1} to 10^8 CFU g^{-1}. For guava, the counts varied from 6.9 x 10^2 CFU g^{-1} to 6.0 x 10^6 CFU g^{-1} and for melon from 2.6 x 10^3 CFU g^{-1} to 1.8 x 10^6 CFU g^{-1}. Microbiological criteria (IFST, 1999) for non-thermally processed fruit established that a maximum yeast count of 6 log CFU g^{-1} is considered acceptable at any point in the shelf-life of a fruit product. In this study, yeast counts did not exceed these levels at any time during storage.

Resolution RDC Nº 12/2001 (Brasil, 2001) of the Ministry of Health of Brazil establishes the microbiological standards for Brazilian foods, but there are no specific standards for minimally processed vegetables. However, if this group of products are classified as “fresh fruits, *in natura*, prepared (peeled, selected or fractioned), sanitized, and refrigerated or frozen, for direct consumption,” the limit established by this regulation is a maximum of 5 x 10^2 MPN/g or CFU g^{-1} of heat tolerant coliforms. In the present study, the presence of heat tolerant coliforms was below the detection limits (< 1 log CFU g^{-1}) throughout the entire storage period in

all of the treated samples, showing that they fit to the Brazilian microbiological standards. Mattiuz, Durigan and Rossi Júnior (2003) found similar results in their microbiological evaluation of minimally processed guavas of the varieties Paluma and Pedro Sato, stored at 3 °C, for 10 days. Neither did Carvalho and Lima (2002) detect total or fecal coliforms in their study on the microbiological quality of minimally processed kiwis treated with 1% solutions of citric acid, ascorbic acid and calcium chloride stored at 1 °C, for 10 days.

SENSORY ANALYSIS

The consideration of consumer preferences is important for increasing consumer satisfaction in peach consumption. A consumer test was performed to obtain information regarding consumer preferences regarding the appearance, color, flavor, texture and overall acceptance of the product. The results of the acceptability assessment to the six treatments for three storage days are presented in Table 2. The samples were not evaluated in the 9 day in regards to the consumer sensory test because after 7 days, they no longer had acceptable sensory appearance. The firmness attribute had no significant difference between treatments along the storage. On the seventh day of storage, peach samples treated with the T5 received higher scores in appearance, color, flavor and overall preference compared with the other treatments. This result can be justified by higher values of TTA and TSS found in T5, which is directly related to the flavor. Fontes, Sarmento and Spoto (2007) concluded that MPR Apple cv. Royal Gala, treated with combined solution (1% ascorbic acid, 0.5% citric acid, 0.25% calcium chloride and 0.7% sodium chloride) showed prominent scores of the parameters appearance, odor, and texture, similar the freshly cut apple *in nature.*

The treatment T4 caused some negative effects on sensory characteristics of peach slices, particularly in appearance and color, which can be associated with their low values of texture at day-7 of storage.

Table 2. Effect of different treatments of sensory quality of the fresh cut peaches with CA (2kPa O_2, 5kPa CO_2, 93kPa N_2) during storage at 5 °C ± 2 °C.

Parameter	Treatments	0	5	7
Appearance	Control (T1)	3.6 ^{Ca}	3.0 ^{BCDa}	2.7 ^{CDb}
	T2	3.7 ^{Bca}	2.9 ^{CDb}	3.3 ^{Bcab}
	T3	3.9 ^{Aca}	3.2 ^{BCb}	3.4 ^{Bab}
	T4	3.8 ^{Aca}	2.5 ^{Db}	2.1 ^{Db}
	T5	4.4 ^{Aa}	4.2 ^{Aa}	4.5 ^{Aa}
	T6	4.3 ^{Aba}	3.6 ^{ABb}	3.5 ^{Bb}
Color	Control (T1)	3.4 ^{Ba}	3.2 ^{BCa}	3.0 ^{Ba}
	T2	3.8 ^{Aba}	3.2 ^{BCb}	3.5 ^{Bab}
	T3	3.8 ^{Aba}	3.4 ^{Ba}	3.6 ^{Ba}
	T4	3.8 ^{Aba}	2.5 ^{Cb}	2.1 ^{Cb}
	T5	4.4 ^{Aa}	4.2 ^{Aa}	4.5 ^{Aa}
	T6	4.2 ^{Aa}	3.7 ^{ABab}	3.4 ^{Bb}
Flavor	Control (T1)	3.7 ^{Aa}	3.5 ^{Aa}	3.3 ^{ABa}
	T2	3.6 ^{Aba}	3.4 ^{Aab}	2.9 ^{BCb}
	T3	2.9 ^{Bab}	3.2 ^{Aa}	2.5 ^{Cb}
	T4	3.9 ^{Aa}	3.1 ^{Ab}	3.6 ^{Aa}
	T5	3.5 ^{Aba}	3.6 ^{Aa}	3.1 ^{ACa}
	T6	3.3 ^{ABa}	3.7 ^{Aa}	3.1 ^{ACa}
Firmness	Control (T1)	3.8 ^{Aa}	3.7 ^{Aa}	3.8 ^{Aa}
	T2	3.8 ^{Aa}	3.3 ^{Aa}	3.5 ^{Aa}
	T3	3.6 ^{Aa}	3.6 ^{Aa}	3.2 ^{Aa}
	T4	3.9 ^{Aa}	3.4 ^{Aa}	3.5 ^{Aa}
	T5	3.9 ^{Aa}	3.9 ^{Aa}	3.8 ^{Aa}
	T6	3.7 ^{Aa}	3.7 ^{Aa}	3.4 ^{Aa}
General acceptance	Control (T1)	3.7 ^{Aa}	3.5 ^{Aa}	3.3 ^{ABa}
	T2	3.7 ^{Aa}	3.2 ^{ABb}	3.1 ^{ABb}
	T3	3.5 ^{Aa}	3.3 ^{ABa}	2.7 ^{Bb}
	T4	3.8 ^{Aa}	2.8 ^{Bb}	3.0 ^{ABb}
	T5	3.9 ^{Aa}	3.7 ^{Aa}	3.6 ^{Aa}
	T6	3.5 ^{Aa}	3.7 ^{Aa}	3.2 ^{ABb}

NOTE: Different letters in column (A,B,C) and in rows (a,b,c) indicate significant differences between treatments according to Tukey's test with a P value of 0.05.

CONCLUSION

The combination of 1% ascorbic acid + 1% citric acid + 1% calcium chloride with modified atmosphere (2kPa O_2, 5kPa CO_2, 93kPa N_2) has provided better maintenance of quality evolution of fresh cut peaches along storage time. The treatment T5 received higher scores in appearance, color, flavor and overall preference by sensory analysis, the

highest values of TSS and TTA and the lowest values of total sugars and pH at the end of the storage in comparison with the other treatments. In relation to microbiological evaluation, the treatment T5 exhibited low growth rates over 9 days of storage. This could be explained by the mean pH values below 4.0 and also by the possible bactericidal properties of organic acids. Additionally, the use of modified atmosphere has a direct relationship to the microbial count.

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Uso de aditivos naturais e de atmosfera modificada na qualidade de pêssegos minimamente processados

RESUMO

O objetivo deste trabalho foi avaliar o efeito do uso combinado de aditivos naturais e atmosfera modificada nas características físico-químicas e microbiológicas de pêssegos minimamente processados. O processamento mínimo consistiu de lavagem, descasque e sanitização. As fatias dos frutos foram submetidas aos tratamentos: água destilada (T1, controle); $CaCl_2$ a 2% (T2); ácido ascórbico a 2% (T3); ácido cítrico a 2% (T4); $CaCl_2$ a 1% + ácido ascórbico a 1% + ácido cítrico a 1% (T5); $CaCl_2$ a 2% + ácido ascórbico a 2% + ácido cítrico a 2% (T6). As amostras foram acondicionadas em bandejas de polietileno, envolvidas por filmes de polietileno com atmosfera modificada de 2 % O_2, 5 % CO_2 e 93 % N_2 e armazenadas em câmara fria a 5 °C ± 2 °C, por nove dias. Nos dias 0, 5, 7 e 9, foram avaliados: sólidos solúveis totais, acidez titulável, pH , açúcares totais, textura, contagem total de aeróbios, contagem de coliformes a 45 °C, contagem de fungos e leveduras e análise sensorial dos atributos aparência, cor, sabor, textura e aceitação global. O tratamento T5 aliado ao uso de atmosfera modificada manteve melhores características qualitativas e microbiológicas para pêssegos minimamente processados durante nove dias de armazenamento.

PALAVRAS-CHAVE: Minimamente processados, *Prunus persica*, Aditivos naturais, Atmosfera modificada.

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