RESEARCH ARTICLE OPEN ACCESS

Quality of minimally processed "Poncã" tangerine packaged in different packaging

Aline Silva Pietro*, Rodrigo Esaú Vassoler e Silva**, Patrícia Monique Crivelari Costa***, Daniella Moreira Pinto****, Luiz José Rodrigues*****
**Regional Department of SESI and SENAI of Mato Grosso.*
***, *****Department of Food and Nutrition, Faculty of Nutrition, Federal University of Mato Grosso (UFMT), 78060-900, Cuiabá MT, Brazil,*
****Department of Tropical Agriculture, Federal University of Mato Grosso (UFMT)*
***** Department of Food Engineering, University Center of Várzea Grande (UNIV)*
Corresponding Author: Aline Silva Pietro

ABSTRACT
The residual odor in the hands of consumers when removing the bark of "Poncã" tangerine can considered a limiting facto of its commercialization and consumption, so the minimal processing of the fruit could emerge as an alternative of convenience, as well as combining sensory and nutritional quality and sanity. The objective of this study was to evaluate the effect of different packages on the maintenance of quality and shelf life of minimally processed "Poncã" tangerine stored at 5ºC for 15 days. The 2013 harvest tangerines was acquired in local trade of Cuiabá/MT, were selected for maturation (50% green bark coloration) and absence of injuries, washed and sanitized with sodium hypochlorite (200mg.L^{-1}) for 15 minutes. Subsequently, they were peeled and packaged in the packaging: 1) Polystyrene without plastic film (control); 2) Polystyrene with PVC film 15µm; 3) Polypropylene with rigid lid (same polymer), and stored at 5±1ºC and R.H. 90±5%, for 15 days. Analyzing the parameters of mass loss (%), juice yield (%), titratable acidity (% citric acid), pH, soluble solids (ºBrix) and vitamin C (mg of ascorbic acid 100g^{-1}). The polypropylene packaging was more efficient for mass loss, juice yield and pH, while the polystyrene packaging with PVC film was better for the maintenance of vitamin C. Soluble solids showed a reduction in their contents along the storage, regardless of packaging. Based on the parameters evaluated, the shelf life of the minimal processed "Poncã" tangerine was 12 days.
Keywords-Citrus reticulatablanco, Minimal processing, Cooling Packaging Storage

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Date Of Submission: 20-10-2019 Date Of Acceptance: 03-11-2019

I. INTRODUCTION

Due to its excellent acceptance in the fresh fruit market, ' Poncã ' is the most cultivated among all tangerine cultivars in Brazil. The fruit stands out for gathering sensory attractiveness of appearance and flavor, soft and characteristic, appreciated by consumers and by constituting themselves in a vehicle of vitamins (A, B and C), minerals (calcium, sodium and potassium) and bioactive compounds, in addition to their bark that loose with ease of the buds, which differentiates it from other citrus. The Tangerine ' Poncã ' they still characterized as little juicy, large, globose and moderately flattened, thin bark and little adherent, pulp of orange color and soft, with few seeds [1].

However, the presence of residual odor in the hands of consumers by removing the bark of ' Poncã ' tangerine can they considered a limiting factor from the point of view of its commercialization and consumption.

Nevertheless, the minimal processing of the fruit could emerge as an alternative of convenience, as well as combining sensory and nutritional quality and assurance of food security, attributes so acclaimed by consumers in the current times.

Minimally processed products they defined as any fruit or vegetable or, even, any combination between them, which they been altered physically from its original form, although it retains its fresh state. Regardless of type, we selected, washed, peeled and cut, resulting in a 100% usable product that is subsequently packaged or pre-packaged in order to offer consumers freshness, convenience and nutritional quality [2].

One of the biggest obstacles of minimally processed products is its rapid deterioration. The physiology of these products is essentially that of an injured tissue caused by mechanical damage resulting from peeling and cutting, stimulating the emergence of undesirable physiological changes. Cellular integrity is lost, destroying the compartmentation of enzymes and substrates, resulting in increased ethylene synthesis and

respiratory rate, besides the formation of secondary metabolites [3].

In the ' Poncã ' tangerine, the removal of the peel and the fibers that cover the pulp promotes important physiological alterations, such as the acceleration of senescence and metabolic changes. The fruits become more susceptible to the microbiological attack because a consequence of the possible loss of vesicular juice and the absence of shell protection [4].

The use of low temperatures during the storage of minimally processed vegetables is a key process in maintaining the quality of these products. Low temperatures reduce the metabolism and respiration rate of the fruits, in addition to slowing other physiological, biochemical and microbiological processes causing deterioration [5].

Allied to refrigeration, it stands out the use of modified atmosphere, which consists in the packaging of the plant product in a sealed and semipermeable package to gases, in order to reduce the concentration of O2 and increase the CO2 inside it[6]. Many types of films and packaging are available on the market for use in minimally processed products. The packaging can be plastic trays or polystyrene (styrofoam), with lid or wrapped in plastic films, and plastic bags of different compositions [7].

The objective of this work was to evaluate the effect of different types of packaging in the maintenance of quality and shelf life of minimally processed ' Poncã ' tangerine stored at 5 º C for 15 days.

II. MATERIAL AND METHODS

The ' Poncã ' (Citrus reticulata Blanco) Tangerines from the 2013 harvest they acquired in the local trade of Cuiabá/MT, where they first selected for maturation (bark with 50% green coloration) and size. Then, they transported to the laboratory of Post-harvest Technology of Fruits and Vegetables of the Department of Food and Nutrition (DAN) of the Federal University of Mato Grosso (UFMT), Cuiabá/MT, which was previously washed and sanitized, Together with all materials to be used, with alcohol 70% and sodium hypochlorite at 200 mg. L-1. For the execution of the minimum processing, all the necessary personal protective equipment (PPE), such as gloves, coat, bonnet and mask.

In the laboratory, the Tangerines they selected for the absence of injuries and defects, washed with neutral detergent and running water and sanitized with sodium hypochlorite 200 mg. L-1 for 15 minutes (8 ° C and pH 6.5).

After the immersion time, the fruits we peeled manually, and the fibers that covered the pulp they removed and then packed in different packages:

1) Expanded polystyrene tray (27, 5cm x 15, 0cm x 1, 5cm), without film wrapping Plastic (control);
2) Expanded polystyrene tray (27, 5cm x 15, 0cm x 1, 5cm), wrapped manually with polyvinyl chloride (PVC) film of 15 micron thickness, flexible and self-adherable;
3) Rigid polypropylene (PP) packing (15, 0cm x 15, 0cm x 40, 0cm), with rigid lid attachable from the same polymer.

The packages containing the minimally processed tangerines were stored in B.O.D. at 5 ± 1 º C and relative humidity of 90 ± 5% for 15 days. The following analyses were performed every 3 days:

Mass loss-calculated by the difference between the initial mass of the tangerines packed on the day of processing and the mass obtained in each storage time interval, using the scale analytical Mars (model LC2) and expressed in percentage;

Juice yield-calculated by the weight of the juice extracted from the two fruits of each repetition relating to the weight of the whole fruits, multiplied by 100 and divided by the respective weight of the whole fruits, using scale analytical Mars (model LC2);

Soluble solids (SS)-determined by refratometry, using manual refractometer and the results expressed in degrees ° Brix [8]

Titratable acidity-performed by titration with NaOH 0.1 N solution, having as indicator Phenolphthalein, according to [9], and the results expressed in percentage of citric acid 100g-1 of sample;

pH – Determined using digital Phmeter (DLA-PH) [8]. The analyses of soluble solids, titratable acidity and pH were performed in a filtered homogenate after fruit juice extraction.

Vitamin C-determined by titration with Tillmans reagent (2, 6dichlorophenolindophenol) to 0.1% [9], with the results expressed in MG ascorbic acid. 100g-1;

Statistical analysis - was performed with the help of the statistical program SISVAR 4.3 [9]. After analysis of variance of the results obtained, the significance level of the F test was observed. The means of the treatments, when significant, were compared by the Scott Knott Test at a 5% probability level. The models of Polynomic Regressions were selected based on the significance of the F test of each model tested and also by the coefficient of determination.

This experiment was conducted in a completely randomized design (DIC), with the treatments arranged in a 3 x 6 factorial scheme, being 3 levels of the packaging factor (expanded polystyrene tray without wrapping plastic film; polystyrene Tray Expanded wrapped with 15 micron PVC film; Rigid polypropylene packing with rigid lid of the same polymer) and 6 levels of storage time

factor (0h, 3, 6, 9, 12:15 days), with 3 replications. The experimental plot consisted of a pack containing about 400g of the minimally processed product (2 units of the fruit).

III. CONCLUSION

The minimally processed ' Poncã ' tangerine samples, regardless of the type of packaging used, did not reach the 15th day of storage at 5 ± 1 º C and relative humidity of 90 ± 5%, due to the visual identification of the presence of fungi. Therefore, the analytical results comprised up to the 12th day of storage.

During the 12 days, all types of packaging promoted increased mass loss with the storage of minimally processed ' Poncã ' tangerine (table 1). However, the polypropylene packaging was more efficient in retaining the loss of the fruit mass, presenting on the 12th day, only 0.56%. After 6 days of storage, the fruits wrapped in polystyrene without plastic film presented 8.64% of mass loss. According to [11], mass losses in the order of 3% to 6% are sufficient to cause a drop in quality. Therefore, the fruits wrapped in polystyrene without plastic film, after 6 days of storage, would already be considered with inferior quality.

Table 1. Mass loss values (%) of minimally processed ' Poncã ' tangerine stored at 5 ± 1 ° C in different packages.

	Storage Time (days)				
Packaging	0	3	6	9	12
Polystyrene without plastic film	0a	5,56a	8,64ª	12,48a	18,08a
Polystyrene with 14 micron PVC	0a	1,93b	1,56b	3,67b	3,76b
Polypropylene with lid of the same polymer	0a	0,14c	0,30c	0,44c	0,56c

* Averages followed by the same letter in the column represent statistical similarities between the packages, at 5% probability, by the Scott-Knott test.

At the end of the storage (12th day), the fruits packaged in all types of packaging presented a drop in their juice yield in relation to the initial value. On the 3rd day of storage, there was statistical difference in the values obtained in the three types of packaging, which did not occur in the following days, where the polystyrene packaging without plastic film and polystyrene with PVC did not present statistical difference. However, the polypropylene packaging showed a yield variation of less than 1% throughout the storage, and the most effective packaging in the maintenance of the juice yield could be considered (table 2).

Table 2. Juice yield values (%) of minimally processed ' Poncã ' tangerine stored at 5 ± 1 ° C in different packages.

	Storage Time (days)				
Packaging	0	3	6	9	12
Polystyrene without plastic film	54,22a	45,21b	48,01a	49,39a	48,58a
Polystyrene with 14 micron PVC	53,12a	40,3c	51,1a	51,11a	50,92a
Polypropylene with lid of the same polymer	54,7la	54,22ª	54,62b	54,61b	54,61b

*Averages followed by the same letter in the column represent statistical similarities between the packages, at 5% probability, by the Scott-Knott test.

The average of the juice yield values obtained at time 0 of all types of packaging was 54.02%, which agrees with the values found by [4], of 54.07% of juice yield at the beginning of the storage. However,[11] found in his study much lower values of juice yield, with values in the order of 43%.

Up to 3 days of storage, the % of TA showed no significant difference between the packages used. In the following times, there was variation of TA among the types of packaging, which showed an increase in TA, finding on the 12th day the highest values and no significant difference between the packaging with PVC and polypropylene (table 3).

Table 3. Titratable acidity values (% citric acid) of minimally processed ' Poncã ' tangerine stored at 5 ± 1 ° C in different packages.

	Storage Time (days)				
Packaging	0	3	6	9	12
Polystyrene without plastic film	0,40a	0,45ª	0,49a	0,50a	0,54a
Polystyrene with 14 micron PVC	0,41a	0,41ª	0,46a	0,55b	0,61b
Polypropylene with lid of the same polymer	0,41a	0,41ª	0,61b	0,51a	0,62b

* Averages followed by the same letter in the column represent statistical similarities between the packages, at 5% probability, by the Scott-Knott test.

Possibly, the fruits were still synthesing their organic acids, so they were not totally ripe, because according to [13], citric acid in the tangerines

accumulates in the green fruits and its content falls sharply in the fruits Completely mature.

The titratable acidity (TA) of the minimally processed ' Poncã ' tangerines, expressed as% of citric acid, obtained 0.41% of the fruits average at the beginning of the experiment, being concordant with the result found by [14], obtaining 0.41% of acid Citric. However, [12] found higher values (0.85%) In ripe fruits.

In relation to pH, in time 0 there was no influence of the treatments, and in times 3, 6 and 12, the polypropylene packaging showed statistical difference of the other packages, presenting lower pH values, that is, keeping the fruits more acidic, with Exception of Time 9 (table 4).

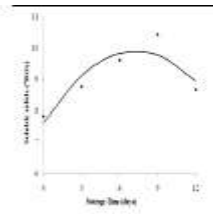
Table 4. Minimally processed ' Poncã ' tangerine pH values stored at 5 ± 1 ° C in different packages.

	Storage Time (days)				
Packaging	0	3	6	9	12
Polystyrene without plastic film	4,32a	4,32b	4,30b	4,46b	4,32b
Polystyrene with 14 micron PVC	4,34a	4,29b	4,29b	4,22a	4,36b
Polypropylene with lid of the same polymer	4,31a	4,17*	4,15a	4,43b	4,24a

* Averages followed by the same letter in the column represent statistical similarities between the packages, at 5% probability, by the Scott-Knott test.
The pH values found initially in this study (4.32) were higher than those found by [14], (4.08) and [15] (4.05).

The content of vitamin C present in the minimally processed ' Poncã ' tangerines did not obtain significant variation between the packages up to 6 days of storage. However, on the 9th and 12th day, the packaging of polystyrene with PVC showed statistical difference among the other treatments. In the fruits packaged in polystyrene packaging without plastic film and polypropylene there was an increase in the content of vitamin C until the 9th day and slight decrease on the 12th day, unlike those packaged with PVC polystyrene, which showed an increase in the content of Vitamin C during the 12 Days of storage (table 5).

Table 5. Values of vitamin C (mg of ascorbic acid. 100g-1) of minimally processed ' Poncã ' tangerine stored at 5 ± 1 °c in different packages.



Polystyrene without plastic film	28,02a	33,92*	33,53a	33,12a	29,95a
Polystyrene with 14 micron PVC	27,07a	33,98*	33,09a	35,90b	41,44b
Polypropylene with lid of the	26,54a	31,68*	32,06a	30,85a	30,06a

* Averages followed by the same letter in the column represent statistical similarities between the packages, at 5% probability, by the Scott-Knott test.
The mean of the results initially obtained (27.21 mg ascorbic acid. 100g-1) are in disagreement with those found by [15], (32.47 mg ascorbic acid. 100g-1), [14], (56.71 mg ascorbic acid. 100g-1) and [4] (59.08 mg ascorbic acid. 100g-1).

Vitamin C is unstable in the presence of light, heat and oxygen, and also, due to the injuries caused in the tissues by minimal processing, it is easily degraded, so it is normal to decrease during storage [15]. However, in this study, in contrast, there was an increase in its content during 9 days of storage. In this way, it confirms the fact that the fruits were not yet completely ripe, synthesing vitamin C during this time. The packaging of polystyrene with PVC continued to provide up to the 12th day conditions for the synthesis of the same (41.44 mg of ascorbic acid. 100g-1), unlike the other treatments, which on the 12th day presented a drop in the ascorbic acid content, therefore, Being less effective in maintaining vitamin C in minimally processed ' Poncã ' tangerines.

The variable soluble solids was statistically significant only in relation to storage time. The soluble solids content increased until the 9th day, where the maximum production of this variable occurred and in the 12th, a fall, probably due to the consumption of the same as substrate in the respiratory process (Figure 1).

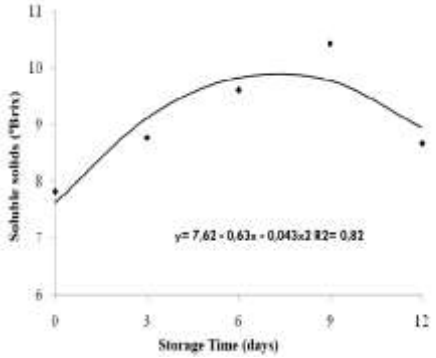


Figure 1. Mean values of soluble solids in minimally processed ' Poncã ' tangerines stored for 12 days.

[14], also obtained soluble solids contents varying with storage time, however, the behavior was different, which fell from the content until the 9th day and later increasing. However, the contents of soluble solids that were initially found in this study (7,83 ° Brix) were below those found by [13] and [11], 10,28 ° Brix and 10,08 ° Brix, respectively.

The soluble solids content is dependent on the maturation stage in which the fruit is harvested and usually increases during maturation by the biosynthesis or degradation of polysaccharides [11]. The accumulation of sugars is associated with the development of the full edible quality of the fruit, which may be derived from the sap imported by the fruit before the degradation of starch [16]

IV. CONCLUSION

The polystyrene packaging with 14 micron PVC film is the most suitable for the packaging of the minimally processed ' Poncã ' tangerine stored at 5 ± 1 °c and 90 ± 5% relative humidity, since this package provided the highest values of vitamin C during Storage, in addition to the other parameters evaluated were not very significant in relation to the polypropylene packaging.

The shelf life of the minimally processed ' Poncã ' tangerine stored at 5 ± 1 ° C and relative humidity of 90 ± 5% was 12 days.

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Aline Silva Pietro" Quality of minimally processed "Poncã" tangerine packaged in different packaging" International Journal of Engineering Research and Applications (IJERA), vol. 9, no. 10, 2019, pp 52-56