

Influence of different coatings and storage temperatures on the quality of guava fruits

ABSTRACT

The culture of the guava tree (*Psidium guajava* L.) comes with a cultivation alternative of Brazilian semiarid region, being source of income for the small farmer, however after the crop the fruits these go by a fast deterioration process, becoming necessary the use of methodologies that you/they seek to delay the ripening and consequently to reduce the losses. In this context, it was aimed at with this to evaluate influences of the application of eatable coverings the base of starch, associated arrowroot or not to the pomegranate oil in the conservation in post harvest of the guava tree 'Paluma'. The experiment was driven in desing entirely randomized, in factorial outline 2 x 4, two storage temperatures ($20 \pm 2^\circ \text{C}$ for 12 days and $10 \pm 2^\circ \text{C}$ for 20 days, both with $85 \pm 5\%$ UR) and four types of coverings (T1: without application; T2: 0,3% pomegranate oil; T3: arrowroot until 2% and T4: arrowroot to 2% + 0,3% pomegranate oil, with five repetitions of two fruits. The use of the base arrowroot starch in 2%, was shown efficient in the control of the ripening of the guavas stored in different temperatures, and the covering of arrowroot starch to 2% + 0,3% of pomegranate oil, it potentiated more the reduction of the breathing tax of guavas, providing the maintenance of the shelf life post harvest of the fruits in both storage temperatures. Moreover, the covering of starch of araruta 2% + 0,3% of pomegranate oil provided a better shelf life in guavas for 20 days of storage the temperature of $10 \pm 2^\circ \text{C}$ with $85 \pm 5\%$ UR.

Keywords: *Psidium guajava* L.; arrowroot starch; pomegranate seed oil; post haverst; shelf life.

1. INTRODUCTION

The guava (*Psidium guajava* L.) is a fruit most cultivated in the world, including Semiarid Brazilian, being source of small family farmers' of this area income. It's considered very rich in nutritional elements and commonly consumed in natura [26]. However, life useful post harvest is committed due to high breathing tax and consequently the fast ripening [12]. The climacteric nature of the guava limits life useful post harvest between 3 and 4 days when stored the temperature from 28 to 30°C [17]. After, is necessary to evaluate the use of eatable coverings as a method that can reduce the losses and to maintain the quality of the guava during the storage [2].

The biodegradable coatings are made mainly of polysaccharide, protein, with addictive functional as vegetable and essential oil, agents antimicrobial and antioxidants, could be applied in fruits and vegetables with the purpose of reinforcing the protecting action of the natural skins in the prevention of the loss of water, coloration changes, mechanical lesions and even microbial deterioration, besides usually to give shine to the surface [18,25].

Among the coatings they are had the arrowroot starch, which presents great nutritional characteristics, joining lightness and high digestibility, besides the gluten absence, what turns them advisable for people that present alimentary intolerance [19]. These coatings can also be composed pomegranate seed oil to be attractive nutraceutical ingredient, that it possesses a phytochemical composition enriched with high pubic acid and antioxidant activity, due to the presence of compositions phenolic, especially ortho-diphenols [28].

The application of eatable coatings starting from starches of starch represents a potential alternative in the conservation of fruits, what has been waking up several studies on the effects of these eatable coverings in guava tree [21,15,2,5,20]. However, they are rare the works that treat of the conservation post harvest of fruits using obtained biofilms of rhizomes starting from arrowroot starch (*Maranta arundinacea* L.), associates or not to pomegranate seed oil.

Another form of to reduce the losses during the post harvest and to prolong the useful life of the fruits is the use of the cooling, that consists of the removal of the heat of the atmosphere where these will be stored, should reduce the microbial activity and the breathing taxes and consequently to delay the senescence of the fruit caused by the production autocatalytic of the ethylene (GANAI et al. 2018).

In this context, did this work have as objective the application of eatable coatings of the starch of associated arrowroot or not to pomegranate seed oil in the conservation post harvest of the guava 'Paluma'.

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43 2. MATERIALS AND METHODS

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The experiment was carried in the Federal University of Campina Grande (UFCG), in the Center of Sciences and Technology Agro-Food (CCTA), in the laboratory of Fruits and Vegetables, in the period of November to December 2017. The fruits were obtained of orchards, located in the state of Pernambuco, Northeast area of Brazil.

The installation of the experiment was made in completely randomized design, in factorial outline 2 x 4, two storage temperatures ($10 \pm 2^\circ\text{C}$ and $20 \pm 2^\circ\text{C}$, both with $85 \pm 5\%$ UR) and four coatings types; T1: without application; T2: 0,3% pomegranate seed oil; T3: arrowroot starch to 2% and T4: arrowroot starch to 2% + 0,3% pomegranate seed oil.

The crop of the fruits was accomplished in the period of the morning, where they were reelected in the field, being excluded the ones that presented signs of diseases, presence of pathogens or some mechanical damage, conditioned in only layer, in cardboard box with dimensions of (640 x 480 cm) previously covered with the sack bubble to minimize the impact and the attrition among the same ones and transported to the laboratory where the fruits were selected as for the size uniformity and color, discarding those with defects or apparent offenses due to the transport, where they were cleaned of the same ones with a detergent solution to 1% and sodium hypochlorite solution 200 ppm of active chlorine, with immersion for 20 minutes, and subsequent it rinses in water, later dried outdoors on bench.

The solution of arrowroot starch was prepared in the concentration of 2% (w/v), through obtaining gels of the starch that consisted of the heating of the solution to the temperature of 70°C , under constant agitation being cooled later for the coating in the fruits. For the incorporation of the covering in the fruit, 0,3 ml pomegranate seed oil was used for 1 liter of the solution of arrowroot starch, with the purpose of to emulsify and to maximize the plastification properties of the coating. Later, the fruits were conditioned in camera acclimatized $10 \pm 2^\circ\text{C}$ $85 \pm 5\%$ UR, where they stayed for 20 days and conditioned in camera acclimatized $20 \pm 2^\circ\text{C}$ $85 \pm 5\%$ UR, where they stayed for 12 days, with five repetitions of two fruits for portion. In the day of the installation of the experiment, analyses were accomplished in the guavas for the characterization of the fruits in the moment of the crop, presenting the following values, according to the (Table 1).

Table 1. Initial characterization of the guava fruits before the application of the different coatings, UFCG, Pombal, 2018.

Initials Characteristics	Averages $\pm$ DP
Loss of fresh Mass (g)	113.73 ± 1.35
External brightness (L^* of the peel)	52.34 ± 2.08
External chromaticity (C^* of the peel)	37.39 ± 1.75
External hue angle (H° of the peel)	180.17 ± 0.20
Internal luminosity (L^* of the pulp)	69.69 ± 2.55
Internal chromaticity (C^* of the pulp)	25.98 ± 2.12
Internal hue angle (H° of the pulp)	123.42 ± 9.19
Firmness (N)	122.89 ± 3.97

Soluble solids (%)	6.22 ± 0.73
Titrateable Acidity (% citric acid)	0.56 ± 0.06
Ratio	10.75 ± 0.08
Hydrogen potential	4.27 ± 0.09
Vitamin C (mg.100g ⁻¹)	17.94 ± 0.83

Soon afterwards, the fruits were processed in domestic and appraised centrifuge for the following aspects:

Loss of fresh mass: It was accomplished in semi-analytical scale accurately of ± 0,01g, being used the connection between the mass of the fruit on the day of the crop and in the date of each evaluation, being the expressed results in percentages;

Firmness of the pulp: took place after the removal of the peel of the fruit with sheet of 10 mm being used a digital penetrometer coupled to the ferrule measuring 8 mm in diameter. Took place two evaluations for fruit, in sides opposed in the equatorial area. The results were expressed in N. [1];

Coloration (peel and pulp): it was certain through the system L *, a * and b *, done by efectometry, being used a reflectometer marks Konica Minolta, model Chroma to put CR-400. The readings were accomplished randomly in the equatorial area by the fruit. The measured color parameters regard to plate-pattern they were: brightness (L *), that it varies of the black color (0) to the white (100); a *, that it varies from green color (-60) to red (+60) and b *, that it varies from blue color (-60) to yellow (+60). Starting from the values L *, a *, b *, they were calculated the angle Hue (°h *) and the saturation index chromes (C *) [22];

Hydrogen potential (pH): determined directly in the pulp, in triplicate using a digital potentiometer with electrode of glass membrane, gaged with solution lid of pH 4,0 and 7,0. (Marks Digimed DM-22), [13];

Titrateable acidity (AT): certain through titration of 1g of homogenized pulp and diluted in 50 ml of distilled water. In the sample, it was added three drops of the phenolphthalein indicator 1%, being proceeded titrating under constant agitation, with solution of NaOH 0,1 N, being the expressed results in % of citric acid [13];

Soluble solids (SS): certain through direct reading in digital refractometer mark DigitalRefractometer [1];

Ratio: it was obtained becoming separated the values of soluble solids for the values of the titrateable acidity.

Vitamin C: certain through titration with solution of Tillmans, that bases on the reduction of the color sodic salt of 2.6-dicorofenol indofenol (DFI) for a solution acid of vitamin C. Initially 1 g of the sample was weighed in analytical scale, being transferred later for an Erlenmeyer being completed the volume for 50 mL with oxalic acid to 0.5%, even obtaining of coloration rosy permanent clearing, and the results were expressed in% of ascorbic acid [1].

The data were submitted to the test F 5% of significance, through variance analysis (ANOVA) and the average test was applied Tukey. The analyses statistical form accomplished in the software SISVAR version 5.6 [8].

3. RESULTS AND DISCUSSION

The variance analysis for the variables brightness, chromatically and external hue angle (peel) and internal (pulp) of the guava fruits it was influenced significantly by the different coatings and for the storage temperature, showing that both factors influence simultaneously on the parameters of colorimetry of these fruits (Table 2).

Table 2. Summary of the analysis of variance of the brightness (L*), chromaticity (C*) and hue angle (H°) external (Peel) and internal (pulp) of guava fruits in function of different coatings and two storage temperatures, UFCG, Pombal, 2018.

FV	GL	Medium square					
		External coloration			Internal coloration		
		L*	C*	H*	L*	C*	H*
Coating (R)	3	194.47**	337.9**	383.96**	1134.54**	422.79**	304.25**
Temperatures (T)	1	241.52**	1231.6*	197.04**	920.92**	328.73**	38.12**
R x (T)	3	13.38*	188.9**	126.28**	127.13**	43.36**	45.93**
Residue	32	2.91	7.24	6.69	23.47	13.37	4.60
Total	39						
CV (%)		2.46	5.07	2.90	6.94	7.11	2.37
General average		69.33	53.08	89.23	69.84	51.41	90.72

ns: No significant; * significant to 5% of probability for the test F; ** significant at the level of 1% of probability for the test F.

About brightness (L *) of the fruits, was verified that they stored to 10°C, the treatments T3 (starch) and T4 (starch + pomegranate seed oil) they were more efficient, not differing statistically amongst themselves, presenting intense shine in the whole surface expresses (peel) (Figure 1B). Both coverings were effective in the shelf life of external visual aspect of the guavas (Table 3). Those alterations in the coloration of the fruits with the ripening happen due to degradation of the chlorophyll and/or of carotenoid synthesis, being that one of main judgment criteria for the maturation stadium and maintenance of the color, for the fact of being a quality attribute, because it contributes with the appearance and has direct influence in the consumer's preference [6].

The fruits without covering and stored 20 °C suffered a process of faster ripening than the other treatments, demonstrating tone change for the yellow (Figure 1A). Results fellow creatures were found for [20] where they observed brightness of 65.00, after 15 days of storage under cooling in the guava fruits 'Paluma' submitted to the covering starch base for 2%. [29] when studying guava covered with eatable covering to the base of O-carboximetilquitosana and essential oil oregano (*Origanum vulgare*), observed that the coverings were efficient, and they contributed to the preservation expresses of the fruits presenting an intense shine in all surface expresses (peel), confirming that the total covering of the fruits provided prolongation of the useful life of the guavas after 17 days of storage.

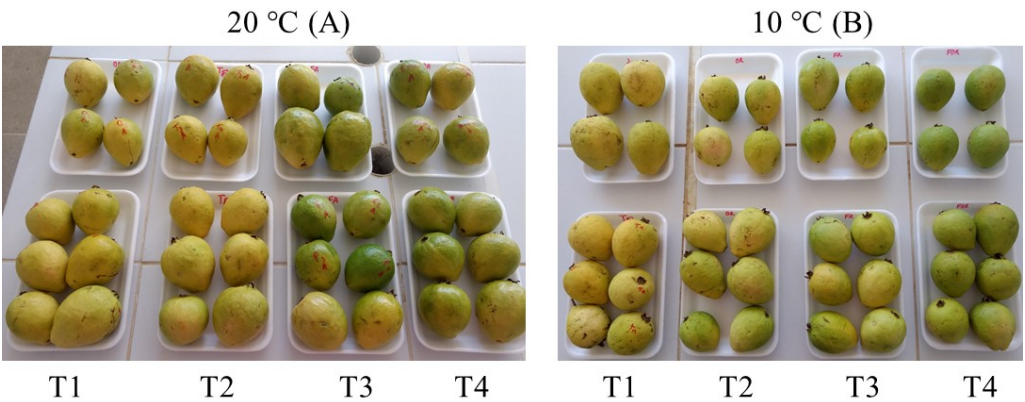


Figure 1. Visual appearance of stored fruits 20 ± 2°C with 85±5% UR for 12 days (1A) and stored 10 ± 2°C with 85±5% UR for 20 days (1B) in function of different treatments (T1: without application; T2: 0,3% pomegranate seed oil; T3: arrowroot starch to 2% and T4: arrowroot starch to 2% + 0,3% pomegranate seed oil), UFCG, Pombal, 2018.

Table 3. Brightness (L*), chromaticity (C*) and hue angle (H°) external (Peel) of guava fruits in function of different coatings and two storage temperatures, UFCG, Pombal, 2018.

	Luminosidade E (L*)		Cromaticidade E (C*)		Ângulo Hue E (H°)	
	10°C	20°C	10°C	20°C	10°C	20°C
T1	65.90 Ca	61.45 Cb	46.27 Da	44.11 Ba	80.49 Ba	80.49 Ba
T2	70.22 Ba	66.09 Bb	55.01 Cb	49.54 Aa	97.17 Aa	82.34 Bb
T3	75.95 Aa	67.72 Bb	63.04 Ba	46.82 ABb	93.43 Aa	90.23 Aa
T4	75.09 Aa	72.23 Ab	70.21 Aa	49.67 Ab	94.72 Aa	95.01 Aa

Note. T1: without application; T2: 0,3% pomegranate seed oil; T3: arrowroot starch to 2% and T4: arrowroot starch to 2% + 0,3% pomegranate seed oil. Averages for the same capital letter in the column and lower case in the line don't differ statistically amongst themselves for the test of Tukey to 5% of probability.

For the Chromaticity (Chroma), indicates the intensity or purity of the color, was observed high values about chromes in the fruits stored in temperature to 10 °C in the treatments T3 (starch) and T4 (starch + pomegranate seed oil) expressing larger intensity of the color, what indicates more alive colors, if compared to the other appraised treatments. The treatment T1 presented inferior values independently to the other treatments of the appraised storage temperature, demonstrating the efficiency of the use biodegradable bio films and or foodstuffs the base of arrowroot starch (Table 3). [9] they told that the coatings with carboxy-methylcellulose delayed the emergence of yellow color in guavas, and the films turn the most opaque fruit, and they delay the synthesis and the degradation of pigments that do with that the fruit acquires shine, delaying the emergence of shine more accentuated.

The angle Hue, is related the shade of the fruit, representing the transition of green color for yellow, independent of the storage atmosphere. In this color parameter similar behavior was verified among the appraised atmospheres, however, the fruits stored 10 °C presented superior values if compared to the stored 20 °C. The treatments T2, T3 and T4 didn't differ statistically amongst themselves, when stored 10 °C therefore, it delayed the metabolism of the fruit through the reduction of the breathing and consequently it hindered the ripening of the fruits (Table 2). It's a relevant result, once it indicates alterations that are characteristic during the ripening, as break of chlorophyll and development of coloration yellows process that was retarded for the application of the coatings. [20] it observed values of angle hue similar to the found in this work of approximately 90° in guava fruits 'Paluma', after 15 days storage under cooling (12°C and 80% UR) and covered with cassava starch to 2%.

For the internal luminosity (pulp) of the guava fruits, it was verified that the treatments T2 and T4 present superior values, differing statistically of the other appraised treatments, when stored in temperature of 10 °C, being in this storage condition, still verified, values superiors to the observed in the fruits stored 20 °C (Table 4). This behavior demonstrates that the storage under cooling (10°C) harnessed to the use of coverings is efficient, is contributing for the preservation of the pulp, and the slowing down in the process of maturation of the guavas, when compared to the fruits without covering.

Table 4. Brightness (L*), chromaticity (C*) and hue angle (H°) internal (pulp) of guava fruits in function of different coatings and two storage temperatures, UFCG, Pombal, 2018.

	Brightness I (L*)		Chromaticity I (C*)		Angle Hue I (H°)	
	10°C	20°C	10°C	20°C	10°C	20°C
T1	55.59 Ca	56.21 Ca	45.01 Ba	39.62 Cb	91.72 Ba	84.76 Cb
T2	82.78 Aa	68.99 ABb	57.98 Aa	46.32 Bb	95.95 Aa	98.54 Aa
T3	72.58 Ba	62.49 BCb	54.61 Aa	52.43 ABa	84.34Ca	84.74 Ca
T4	87.61 Aa	72.49 Ab	59.52 Aa	55.81 Ab	94.74 ABa	90.94 Bb

Note. T1: without application; T2: 0,3% pomegranate seed oil; T3: arrowroot starch to 2% and T4: arrowroot starch to 2% + 0,3% pomegranate seed oil. Averages for the same capital letter in the column and lower case in the line don't differ statistically amongst themselves for the test of Tukey to 5% of probability.

It's verified that in the internal chromaticity index (pulp) was a significant difference among the storage temperatures, where it verified that the treatments, T2 (57.98) and T4 (59.52), they presented superior values of chromes, presenting significant difference to the other appraised treatments, when stored under conditions of refrigerated storage of 10°C. Verifying superior values to the found under storage conditions to 20°C, as presented in the Table 4. During the ripening, it happens a consequent increase of the color index and of the tenor of total soluble solids and this process feels initially until when the peel of the guava becomes partially yellows, when then there is an increase accentuated in the tenor of soluble solids to the beginning of the senescence.

It is observed that for Hue° of the pulp that there was significant difference between the storage temperatures and the types of appraised coatings, presenting better result in the experiment under storage conditions refrigerated to 10°C, where it is observed that presented values of higher hue in comparison with the other treatments in the treatments of T2 and T4. Therefore it's noticed that was observed in relation to pulp that the treatments T2 (pomegranate seed oil) and T4 (arrowroot starch + pomegranate seed oil) they were the ones that preserved more the fruit acting in the process of maturation for the guavas (Table 4). The results corroborate with introduced them for [3,7] for eatable coverings to the hitosan-based in broccolis and melon processed minimally, respectively, whose coatings contributed for a reduction of the senescence of the fruits. [29] when studying guava covered with eatable covering to the base of O-carboximetilquitosana and essential oil oregano (*Origanum vulgare*), it observed that the coverings were efficient, and they contributed to the preservation interns of the fruits providing the slowing down in the process of maturation of the guavas.

In the Table 5 is the analysis of variance of the variables mass loss, firmness, vitamin C, titratable acidity, ratio and pH of guava fruits. It's observed that all these varied were influenced significantly by the appraised factors (storage temperature and different coatings), except pH which didn't present variation in function of the treatments (Table 5).

Table 5. Summary of the analysis of variance of the loss of fresh mass (PM), firmness (F), Vitamina C (VIT C), titratable acidity (AT), ratio and pH of guava fruits in function of different coatings and two storage temperatures, UFCG, Pombal, 2018.

		Medium square						
FV	GL	PM	F (N)	SS	VIT C	AT	RATIO	pH
Coating (R)	3	46.43**	222.23**	1.47**	2182.49**	0.03**	11.61**	0.05 ^{ns}
Temperatures (T)	1	24.74**	295.33**	17.03**	12681.07**	4.38**	395.38**	0.08 ^{ns}
R x (T)	3	5.84*	65.19**	1.23**	1231.22**	0.02**	12.16**	0.10 ^{ns}
Residue	32	0.44	0.67	0.17	5.80	0.001	0.89	0.29
Total	39							
CV (%)		6.18	3.76	3.72	2.64	3.77	8.04	13.53
General average		10.76	21.77	11.11	91.41	1.04	11.74	4.02

ns: No significant; * significant to 5% of probability for the test F; ** significant at the level of 1% of probability for the test F.

In relation to loss of fresh mass of the guava fruits, it was observed that the largest mass loss was verified in the treatments T2 (pomegranate seed oil) and T1 (without bio film application) when stored in temperature of 20°C. The treatments T3 (starch) and T4 (starch + pomegranate seed oil) they reduced the loss of mass of the fruits significantly if compared with the other treatments, however, they didn't differ statistically amongst themselves, independently of the temperature in that the fruits were stored (Table 6). This behavior is related to use of the biodegradable covering as the arrowroot starch, due to maintenance of the appearance, the absence of mushrooms and the decrease of the metabolism delaying the ripening process, maintaining the turgidity and the shine of the fruit [4,30,12].

It was verified although temperature of storage of 10 °C was efficient in the reduction of the loss of fresh mass (Table 6), what can be explained for [24] to they affirm that the synthesis of compositions during the ripening process can vary in agreement with storage atmosphere, and the cooling provides increase of useful life if compared to room temperature, the intermediate products of the breathing metabolism of the fruit, as well as the organic acids, modify the flavor, the aroma, the color, the stability in the reduction of the loss of fresh mass and, consequently, the quality of the fruit.

In what refers the firmness of the fruits, it was verified that the temperature of 10 °C associated to the treatments T3 and T4 present fruits with larger firmness, while to the smallest firmness it was verified in the treatment T1 in the two appraised storage temperatures, demonstrating the coatings associated to the cooling as soon as in the appropriate temperature to delay the breathing and consequently the metabolisms of the guava fruits, turning like this a viable alternative in the maintenance of the quality powders crop of these fruits (Table 6).

In agreement with [5] the firmness of the fruits can reduce the firmness in the period post harvest, as a consequence of the action of enzymes as the pectinamethylesterase, polygalacturonase, cellulase and another that act attacking the structural carbohydrates responsible for the firmness of the vegetable fabrics that act in level of cellular wall for time, during the ripening, having decomposition of macromolecules as pectins, cellulose, hemicellulose and starch. Therefore, the use of the starch the base of associated arrowroot or not to the pomegranate oil it can reduce the performance of these enzymes prolonging like this the quality of the fruits. Similar behavior was obtained for [20] studying the use of eatable coverings to the base of cassava starch associated to the cooling in the quality guava post harvest "Paluma", verifying that the use of the covering acts as physical barrier delaying the loss of firmness of the fruits, if compared to the fruits without the bio film application.

In the tenor of soluble solids it was verified that the treatments (T1, T2, T3 and T4) they didn't differ statistically amongst themselves when stored in the temperature to 20 °C, however when stored 10 °C was observed that the treatment T2 and T3 presented the smallest and larger tenor of soluble solids, respectively, soon the fruits stored under cooling (10 °C) they presented smaller tenor of soluble solids if compared to the stored 20 °C (Table 6). The smallest tenor of soluble solids observed in the fruits stored in suave temperature (10 °C) associated to the coatings it is related with the reduction of the breathing tax and of the mass loss due to smaller impermeability to the humidity and

gases (CO₂ and O₂), what consequently reduces the metabolic tax and, therefore, it favors the maintenance of the tenor of soluble solids [30]. [21] evaluating the shelf life post harvest of guavas 'Pedro Sato' in modified atmosphere, associated or not to the cooling and the use of arrowroot starch, it was observed for the tenor of soluble solids of the fruits stored with coating to 3% of arrowroot starch to 10 °C presented 12,58 °Brix.

Table 6. Loss of fresh mass, firmness and soluble solids of guava fruits in function of different coatings and two storage temperatures, UFCG, Pombal, 2018.

	Loss of fresh mass (%)		Firmness (N)		Soluble solids (°Brix)	
	10°C	20°C	10°C	20°C	10°C	20°C
T1	11.49 Bb	13.13 Aa	17.93 Ca	15.71 Db	10.34 Bb	11.90 Aa
T2	12.77 Aa	13.07 Aa	19.06 Ca	18.36 Ca	9.62 Cb	11.80 Aa
T3	8.04 Cb	10.19 Ba	28.62 Ba	21.83 Ab	11.33 Ab	11.96 Aa
T4	7.62 Cb	9.82 Ba	32.36 Aa	20.32 Bb	10.80 ABb	11.66 Aa

Note. T1: without application; T2: 0,3% pomegranate seed oil; T3: arrowroot starch to 2% and T4: arrowroot starch to 2% + 0,3% pomegranate seed oil. Averages for the same capital letter in the column and lower case in the line don't differ statistically amongst themselves for the test of Tukey to 5% of probability.

The vitamin data C of the guava fruits in function of the coatings and of the storage temperatures it demonstrated superior values when stored 10 °C if compared to the stored 20 °C. The largest vitamin tenor C was verified in the treatment T3 following by T4, differing statistically of the other appraised treatments, when stored 20 °C and the smallest value was observed in the treatment T1 in this same temperature. Though stored 10 °C was verified that the treatment T4 presented results superiors to the other treatments (Table 7). Lima et al. [14] evaluating the use of coatings bio-organic told that the degradation of the vitamin C (ascorbic acid) it can be minimized through the use of these coatings, due the fruits treated with starch and sweet herb present larger tenor of this vitamin if compared with the fruits of the treatment controls (without application of the covering), after 15 days of storage to 10 °C. Similar behavior was observed for [20] that studying different concentrations of eatable coverings associated to the cooling in the quality post harvest of guava fruits, they verified superior values of vitamin C in the fruits that were covered with concentration of 2% of cassava starch if compared the witness (without bio film application).

Analyzing the titratable acidity of the guava fruits was verified that there was not significant difference among the appraised treatments when stored 10 °C, however to 20 °C it was obtained superior values in the treatments T1, T2 and T3 not differing statistically amongst themselves, and the treatment T4 presented the smallest values in the same storage conditions (Table 7). The tenors of organic acids, with few exceptions, decrease with the maturation, due to the breathing process or of his/her conversion in sugars. Similar effect was verified for [16] to the evaluate the shelf life post harvest of guavas 'Kumagai', they verified reduction of the acidity in the pulp of these fruits when stored 21 °C and when stored under cooling presented superior values, being able to this behavior is related the intensity of the breathing process. Soares et al. [27] they verified higher values for the titratable acidity of the pulp of guavas 'Pedro Sato' when stored without coating (testifies), in relation to those covered with film of starch and chitosan 1.5%, after 12 days of storage to 22 °C. [6] to the evaluate the covering of guavas with protein films and chitosan in different concentrations, they didn't find significant differences in the titratable acidity of the covered fruits, in relation to the fruits control (without covering).

Table 7. Vitamina C, titratable acidity and ratio of the guava fruits in function of different coatings and two storage temperatures, UFCG, Pombal, 2018.

	Vitamin C (mg 100 ⁻¹)		titratable acidity (% citric acid)		Ratio	
	10°C	20°C	10°C	20°C	10°C	20°C
T1	108.27 Ba	50.20 Bb	1.50 Aa	0.75 Ab	7.93 Ab	13.76 BCa
T2	103.48 Ca	52.58 Bb	1.30 Ba	0.75 Ab	9.07 Ab	12.81 Ca
T3	110.89 Aba	97.75 Ab	1.36 Ba	0.74 Ab	8.81 Ab	15.30 Ba
T4	114.24 Aa	93.93 Ab	1.36 Ba	0.61 Bb	8.59 Ab	17.68 Aa

Note. T1: without application; T2: 0,3% pomegranate seed oil; T3: arrowroot starch to 2% and T4: arrowroot starch to 2% + 0,3% pomegranate seed oil. Averages for the same capital letter in the column and lower case in the line don't differ statistically amongst themselves for the test of Tukey to 5% of probability.

In the results of the ratio was observed that the fruits stored 10 °C presented inferior values to the stored in temperature of 20 °C, however the appraised coatings didn't differ amongst themselves, when stored 10 °C. The largest value of this ratio was verified in the treatment T4, when stored 20 °C and the smallest value was obtained in the treatment T1 when stored 10 °C (Table 7). The ratio is very important, because gives the indicative of flavor of the product, consequence of the swinging among the representatives with sweet and acid flavor of the product [23]. Oliveira et al. [20] evaluating different concentrations of starch associated cassava the cooling, it verified inferior values to the observed in this work for ratio. Demonstrating that the use of the arrowroot starch associated to the use pomegranate seed oil contributes to the maintenance of high tenors of this ratio.

4. CONCLUSION

The use of coating the base of arrowroot starch to 2%, was shown efficient in the control of the ripening of the guavas stored in different temperatures.

Moreover, the coating of arrowroot starch to 2% + 0.3% pomegranate seed oil still potentiated more in the reduction of the breathing tax of guava fruits, providing the maintenance of the shelf life post harvest of the fruits in both temperatures.

The coating of arrowroot starch 2% + 0.3% pomegranate seed oil provided a better shelf life in guavas for 20 days of storage the temperature of 10 ± 2°C with 85±5% UR.

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