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POST-HARVEST QUALITY OF FRESH PITOMBAS SUBMITTED TO DIFFERENT TEMPERATURES AND PACKAGES

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ABSTRACT

The aim was to assess the effect of different temperatures and packages on the post-harvest attributes of fresh pitomba during the storage period. Tested temperatures were 6, 8, 10, 12, and 14±1 °C at 75 ± 5% relative humidity, while packages were polypropylene (PP), low-density polyethylene (LDPE), polyethylene terephthalate (PET), polyvinyl chloride (PVC) + expanded polystyrene (EPS), as well as no packaging (control). Fruits were assessed for 12 days, with three replications with 10 fruits each. Thus, the design used was completely randomized in a 5 x 5 x 7 factorial scheme (5 temperatures x 5 packages x 7 days of analysis). The associated effect of storage at 6 °C associated with LDPE packaging can be recommended to store pitombas for 12 days, as it presents low weight loss. In addition, the temperature of 14 °C can also be used, as fruits showed high values of bioactive compounds.
Keywords: Conservation. Passive modified atmosphere. Refrigeration. Bioactive compounds. *Talisia esculenta* Radlk.

QUALIDADE PÓS-COLHEITA DE PITOMBAS FRESCAS SUBMETIDAS A DIFERENTES TEMPERATURAS E EMBALAGENS

RESUMO

O objetivo foi avaliar o efeito de diferentes temperaturas e embalagens nos atributos pós-colheita da pitomba fresca durante o período de armazenamento. As temperaturas testadas foram 6, 8, 10, 12 e 14 ± 1 °C a 75 ± 5% de umidade relativa, enquanto as embalagens foram polipropileno (PP), polietileno de baixa densidade (LDPE), tereftalato de polietileno (PET), cloreto de polivinila (PVC) + poliestireno expandido (EPS), bem como sem embalagem (controle). Os frutos foram avaliados por 12 dias, com três repetições com 10 frutos cada. O delineamento utilizado foi inteiramente casualizado em esquema fatorial 5 x 5 x 7 (5 temperaturas x 5 embalagens x 7 dias de análise). O efeito associado do armazenamento a 6 °C associado à embalagem de PEBD pode ser recomendado para armazenamento de pitombas por 12 dias, pois apresenta baixa perda de massa. Além disso, a temperatura de 14 °C também pode ser utilizada, pois os frutos apresentaram altos valores de compostos bioativos.
Palavras-chave: Conservação. Atmosfera modificada passiva. Refrigeração. Compostos bioativos. *Talisia esculenta* Radlk.

1. INTRODUCTION

Considered the second-largest biome in South America, the Cerrado is located in its all extension in the tropical region and represents a high potential for agricultural production not only for Brazil but for the world (PEREIRA; PASQUALETO, 2011). In recent years, the interest of researchers and consumers for native fruit species from this biome has increased considerably, the latter due to concerns related to healthier lifestyles and eating habits (FRAGA *et al.*, 2020).

Talisia esculenta (A. St.-Hil.) Radlk., popularly known as pitomba, belongs to the Sapindaceae family, is a fruit tree found in alluvial floodplains, valley bottoms, secondary formations, or primary forests (ALVES *et al.*, 2013). This species has a great ecological, economic, and medicinal interest, and its fruits are well accepted mainly by the local population of the North and Northeast regions of Brazil, where they are commercialized and consumed fresh as bunches in open markets, on the coast, in supermarkets (FRAGA *et al.*, 2020), and on roadsides, being widely used in the manufacture of jams, jellies, and sweets (VIEIRA; GUSMÃO, 2006).

Thus, studies on the application of post-harvest technologies that allow increasing pitomba commercialization period are needed due to its high commercial value for the fresh market. These studies would provide knowledge, valorization, and dissemination of fruits of this species, as its commercialization is limited due to its high perishability. Among the technologies used to extend the shelf life of fruits is refrigeration associated or not with packaging.

Refrigeration is considered the most important and efficient process to delay post-harvest deterioration, as it consists of reducing the temperature and controlling relative humidity, reducing respiratory rate, transpiration, and metabolic processes involved in the action of degradative and oxidative enzymes, thus delaying product deterioration (SIQUEIRA *et al.*, 2017).

Considering that during storage, refrigeration may not be sufficient to maintain the quality and increase the shelf life of fruits due to the natural ripening process, the association of post-harvest technologies that slow down these processes is essential (SILVA *et al.*, 2016). In this sense, a commonly used association is refrigeration with packaging.

Modified atmosphere packaging is a conservation method that increases the post-harvest life of vegetables, delays the physiological processes, and contributes to increasing the marketing period and the maintenance of vegetable quality (MANTILLA *et al.*, 2010). A passive modified atmosphere is established when the consumption of O_2 and the production of CO_2 by respiration occurs inside the packaging (MANTILLA *et al.*, 2010).

Several polymeric packages are available to store fruits and vegetables. Among the available polymeric packages are low-density polyethylene (LDPE), polyvinyl chloride (PVC), polyethylene terephthalate (PET), and polypropylene (PP) (NASSER *et al.*, 2005).

LDPE films have good O_2 and CO_2 permeability characteristics and good water vapor barrier properties, as well as PVC films, which are thinner and about twice as permeable than LDPE films (NEVES *et al.*, 2002). On the other hand, PP packaging has excellent resistance to breakage, impacts, and good chemical resistance (PIATTI; RODRIGUES, 2005). PET has been one of the most used polymers due to its physical-mechanical characteristics, such as rigidity, resistance to humidity, good chemical resistance, and stability to deformation (NASSER *et al.*, 2005; PIATTI; RODRIGUES, 2005). Thus, it is interesting to assess the differences between packages for fruit conservation.

In this context, this study aimed to assess the effect of different temperatures and packages on the post-harvest attributes of fresh pitomba throughout the storage period.

2. MATERIAL AND METHODS

Pitombas were harvested in an extractive way at Fazenda Córrego da Mata, located in the municipality of Montes Claros de Goiás, northwestern Goiás, Brazil, at the geographical coordinates 16°00’30” S and 51°23’24” W, with an altitude of 424 meters.

Fruits were harvested manually from different plants at the stage of physiological maturation, i.e., when fruit epicarp had a color ranging from light yellow to dark yellow. Fruits were then packaged and transported in expanded polystyrene (EPS) packages to the Laboratory, where they were manually and visually selected for the absence of defects, maturation, and injuries aiming at maximum uniformity in the lot.

After selection, fruits were immersed in a 2% sodium hypochlorite solution for 10 minutes. Fruits were rinsed in distilled water, dried at ambient temperature, and stored in packages of polypropylene – PP (0.40 mm), low-density polyethylene – LDPE (0.08 mm), polyvinyl chloride – PVC (0.01 mm) + expanded polystyrene – EPS (3 mm), polyethylene terephthalate – PET (0.30 mm), and without packaging – WP (control). These packages were stored in a Biochemical Oxygen Demand (BOD) incubator at temperatures of 6, 8, 10, 12, and 14±1 °C and 75 ± 5% RH (relative humidity). Only descriptive analyses were performed on fruits stored under ambient conditions (25 ± 2 °C and 68 ± 5% RH) due to their high perishability.

The experimental design used was completely randomized in a 5 x 5 x 7 factorial scheme (5 temperatures x 5 packages x 7 days of analysis), with three replications of 10 fruits each, during 12 days of storage. Fruits were assessed for non-destructive analyses, such as weight loss and peel lightness, and destructive analyses, such as ascorbic acid content, total extractable polyphenols, and total antioxidant activity (DPPH method).

Fruit weight loss was obtained considering the difference between the initial fruit weight and that obtained at each interval of storage. A Tepron Mark500 precision digital scale with an accuracy of 0.001 g and a maximum load of 500 g was used, with results were expressed as a percentage (%). Peel lightness (L*) was obtained by reflectance using a Konica Minolta CR-400 portable colorimeter, with values indicating how dark (0) and light (100) the product. Ascorbic acid content was determined by titration using 0.02% 2,6-dichlorophenolindophenol, with results expressed as mg ascorbic acid 100 mL^{-1} juice (AOAC 2012).

The contents of total extractable polyphenols were quantified using the Folin-Ciocalteu method (RUFINO *et al.*, 2010), with results expressed as mg gallic acid (GAE) 100 g^{-1} pulp. The total antioxidant activity was determined using the DPPH free radical capture method (2.2-diphenyl-1-picrylhydrazyl) (RUFINO *et al.*, 2010), with results expressed as EC50 g g^{-1} DPPH.

The results were subjected to analysis of variance and, when significant, the means were compared using the Scott-Knott test and regression at a 5% significance level.

3. RESULTS AND DISCUSSION

Storage at ambient temperature (25 ± 2 °C) at 68 ± 5% RH was determinant in the post-harvest quality of pitombas. Fruits maintained their commercial quality for eight days in all treatments. Packages PP, LDPE, and PET (Table 1) were responsible for the lowest weight loss and the least advanced maturity stage. However, PET packaging stood out for having high contents of ascorbic acid, total extractable polyphenols, and total antioxidant activity, i.e., low EC50. The use of packaging in this experiment was relevant to conserve fruits even under ambient conditions. However, the refrigeration associated with packaging promoted an increase in the shelf life of pitombas compared to ambient temperature.

Refrigerated treatments showed that the increased temperature between packages provided a significant increase in weight loss, with low loss values in fruits stored at 6 °C (Table 2). However, less significant losses were found for fruits packaged in LDPE packaging associated with a temperature of 6 °C, reaching a loss of 0.15%. Similarly, Del Aguila *et al.* (2009) used the same packaging and found the lowest weight loss in lychee fruits stored at 5 °C on the 15th day of storage.

The mean variation in weight loss as a function of factors packaging x storage period (Table 2) showed that the percentage of weight loss accumulated over the storage period increased for all packages. Fruits stored in PP and LDPE packages showed no significant differences from each other at the end of storage, with the lowest losses. It is related to the maturation process because, according to Silva *et al.* (2009b), weight loss is an initial symptom of water loss and can be mainly attributed to moisture loss through transpiration and respiration, being one of the main limiting factors of shelf life.

The positive effect found for LDPE packaging, according to Hojo *et al.* (2011), is due to the maintenance of high relative humidity inside, which prevented an increase in the vapor pressure deficit and, consequently, decreased the water loss of fruits through the transpiration process.

The percentage of weight loss accumulated over the storage period increased gradually for all treatments (Figure 1) as storage temperatures increased. Weight loss was more intense in fruits stored at 14 °C, with 7.84% on the 12th day. According to Chitarra; Chitarra (2005), the temperature has a direct influence on vapor pressure, causing water loss. Thus, the lower the temperature, the lower the weight loss, a fact observed during storage.

Table 1 - Pitombas stored at ambient temperature (25 ± 2 °C) at 68 ± 5% RH for eight days in polypropylene (PP), low-density polyethylene (LDPE), polyethylene terephthalate (PET), and polyvinyl chloride (PVC) packages and without packaging (WP).

Variable	Packaging				
	PP	LDPE	PET	PVC+EPS	WP
WL	[1]0.43±0.28	0.71±0.61	0.79±0.55	3.86±2.38	20.23±8.78
L*	52.18±2.13	51.79±3.43	52.27±2.53	49.42±2.79	46.57±4.66
AA	1.12±0.29	1.08±0.15	1.66±1.99	1.44±1.61	1.22±1.23
TAA	5859±1603	7459±3908	2597±1586	3246±1283	3894±1375
TEP	118.66±33	73.74±25	150.86±66	144.26±55	137.67±47

Weight loss (WL, %), peel lightness (L*), ascorbic acid (AA, mg ascorbic acid 100 mL^{-1} juice), total antioxidant activity (TAA, EC50 g g^{-1} DPPH), and total extractable polyphenols (TEP, mg GAE 100 g^{-1}). [1]Mean ± standard deviation.
Source: Authors.

Table 2 - Fresh weight loss (%) of pitombas stored at different temperatures (6, 8, 10, 12, and 14 °C) for 12 days in polypropylene (PP), low-density polyethylene (LDPE), polyethylene terephthalate (PET), and polyvinyl chloride (PVC) packages and without packaging (WP).

Temperature	Packaging				
	PP	LDPE	PET	PVC+EPS	WP
6 °C	[1]0.19 Ac	0.15 Ac	0.39 Ac	1.83 Cb	16.71 Ea
8 °C	0.21 Ad	0.21 Ad	0.68 Ac	2.10 Cb	18.13 Da
10 °C	0.24 Ad	0.21 Ad	0.67 Ac	1.89 Cb	18.81 Ca
12 °C	0.29 Ad	0.35 Ad	0.92 Ac	3.39 Ab	20.11 Ba
14 °C	0.43 Ac	0.51 Ac	0.77 Ac	2.38 Bb	20.79 Aa
Day					
0	0.00 Aa	0.00 Ba	0.00 Ba	0.00 Ga	0.00 Ga
2	0.08 Ac	0.07 Bc	0.21 Bc	0.83 Fb	14.25 Fa
4	0.15 Ac	0.14 Bc	0.39 Bc	1.38 Eb	20.31 Ea
6	0.23 Ac	0.23 Bc	0.60 Bc	2.12 Db	22.14 Da
8	0.38 Ad	0.43 Ad	0.97 Ac	3.18 Cb	24.35 Ca
10	0.49 Ad	0.53 Ad	1.21 Ac	3.96 Bb	25.35 Ba
12	0.57 Ad	0.63 Ad	1.43 Ac	4.73 Ab	26.00 Aa

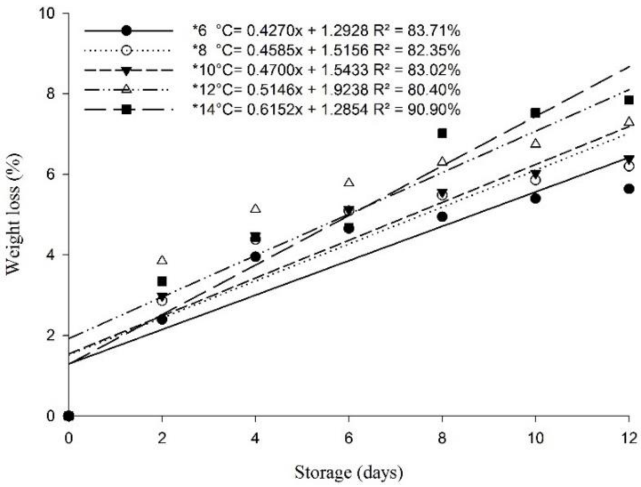
[1]Means followed by the same lowercase letter in the row (comparing means of packages for each temperature and day of analysis) and uppercase letter in the column (comparing means of temperatures and days of analysis for each package) do not differ significantly from each other (p>0.05) by the Scott-Knott test.
Source: Authors.

Table 3 - Peel lightness (L*) of pitombas stored at different temperatures (6, 8, 10, 12, and 14 °C) for 12 days in polypropylene (PP), low-density polyethylene (LDPE), polyethylene terephthalate (PET), and polyvinyl chloride (PVC) packages and without packaging (WP).

Temperature	Packaging				
	PP	LDPE	PET	PVC+EPS	WP
6 °C	[1]44.84 Ca	45.83 Ba	46.56 Ba	45.61 Aa	44.84 Aa
8 °C	45.82 Ba	45.29 Ba	45.90 Ba	45.09 Aa	44.96 Aa
10 °C	43.90 Ca	43.82 Ba	43.95 Ca	43.00 Ba	44.88 Aa
12 °C	46.33 Ba	45.01 Ba	46.32 Ba	44.66 Aa	45.83 Aa
14 °C	49.67 Aa	47.42 Ab	49.55 Aa	45.16 Ac	43.84 Ac
Day					
0	52.95 Aa	52.95 Aa	52.95 Aa	52.95 Aa	52.95 Aa
2	49.87 Ba	50.53 Ba	52.09 Aa	50.83 Ba	45.59 Bb
4	49.26 Ba	49.53 Ba	48.48 Ba	47.36 Ca	42.51 Cb
6	47.26 Ca	46.52 Cb	48.95 Ba	45.75 Db	43.78 Bc
8	46.28 Ca	46.14 Ca	45.01 Ca	44.51 Da	43.61 Ba
10	39.98 Db	36.28 Dc	39.20 Db	37.95 Ec	43.78 Ba
12	36.69 Ec	36.37 Dc	38.53 Db	33.58 Fd	41.88 Ca

[1]Means followed by the same lowercase letter in the row (comparing means of packages for each temperature and day of analysis) and uppercase letter in the column (comparing means of temperatures and days of analysis for each package) do not differ significantly from each other (p>0.05) by the Scott-Knott test.
Source: Authors.

Figure 1 - Weight loss (%) of pitombas stored in packages at different temperatures (6, 8, 10, 12, and 14 °C) for 12 days.



Source: Authors.

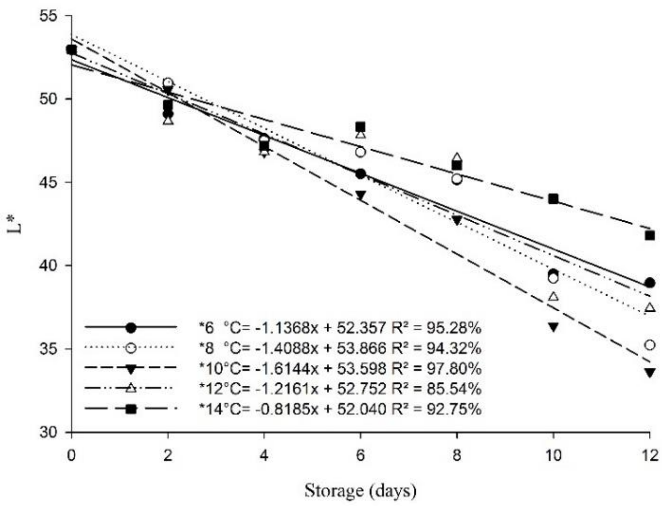
Among a series of transformations that occur in fruits during ripening, changes in color are the most visible (VILAS BOAS *et al.,* 2012), as it is one of the main sensory attributes of food (CORDEIRO *et al.*, 2013). In this context, pitomba peel is very sensitive to browning, mainly due to chlorophyll degradation (SILVA *et al.*, 2009a), caused by water loss during fruit storage (LIN *et al.*, 2017).

Packages associated with temperatures (6, 8, 10, and 12 °C) showed no significant difference (Table 3), except for the temperature of 14 °C, which caused high darkening of peel in fruits stored without packaging (control), followed by PVC+EPS packaging, which did not differ significantly from each other. Pitombas stored in LDPE and PET packages at 6 °C showed high values of lightness (Table 3), indicating that fruits were lighter.

A decrease in lightness was observed for all packages during storage (Table 3), standing out the control treatment (without packaging) with the least darkening. Although the control treatment is responsible for the highest lightness among packages, visually, the treatment was not responsible for the proper maintenance of color during the experiment.

A decrease in lightness values occurred from the 2nd day for all treatments (Figure 2). After the 3rd day, the temperature of 10 °C led to a higher skin darkening, maintaining this behavior until the end of storage. Kaushik *et al.* (2013) explained that this reduction might be associated with an increase in the peroxidase and polyphenoloxidase enzyme activities and microorganism growth. Less expressive decreases were observed for fruits stored at 14 and 6 °C at the end of the 12th day of storage, and these temperatures provided maintenance of the lightness of pitomba fruits.

Figure 2 - Peel lightness (L) of pitombas stored and stored in packages at different temperatures (6, 8, 10, 12, and 14 °C) for 12 days.



Source: Authors.

No significant difference regarding ascorbic acid contents was observed between packages for temperatures of 8, 12, and 14 °C, and LDPE and PVC+EPS packages were responsible for the highest means when fruits were stored at the temperature of 10 °C, differing from the other packages. In contrast, fruits stored in PP packaging had the lowest mean (0.76 mg 100 mL^{-1}), with higher values in the LDPE packaging when stored at 6 °C (Table 4).

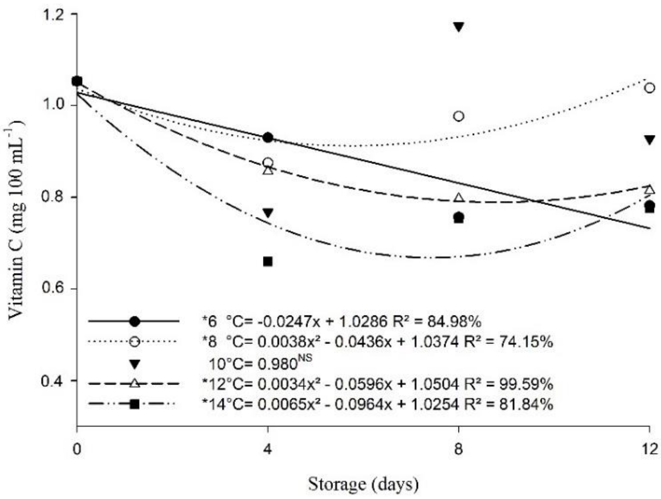
Fruits stored at temperatures of 12 and 14 °C showed the lowest means for this parameter, mainly when associated with the control package (WP), which showed no significant difference, but differed from other temperatures. Low means during storage may occur because organic acids, including ascorbic acids, are consumed in oxidative reactions during fruit ripening and senescence (VIEITES *et al.*, 2011; HOJO *et al.*, 2011).

In addition, packages did not differ significantly from each other until the 4th day, but PP packaging was responsible for the lowest mean on the 8th day, differing from the other packages (Table 4). On the 12th day, PET packaging and the control presented a significant difference in relation to the other packages, which are also responsible for the lowest means on that day of analysis.

Assessing the days for each package, a decrease was observed in this parameter until the 4th day, with subsequent maintenance of low contents for most of the analyzed polymers, standing out the LDPE packaging as responsible for the highest mean on the 12th day. This decrease may be associated with the advancement of the ripening process and can be considered an indicator of fruit quality loss. According to Silva *et al.* (2009a), the determination of vitamin C is important because its presence in the food indicates that the other nutrients are also being conserved.

Ascorbic acid contents decreased with high intensity in fruits stored at the highest temperatures (Figure 3), except for the treatment submitted to the temperature of 8 °C, which presented an increase from the 4th to the 12th day of storage, therefore responsible for the highest mean when compared to the others. According to Agostini *et al.* (2009), this behavior is probably justified because refrigeration inhibited oxidative reactions and delayed physiological processes.

Figure 3 - Ascorbic acid contents (mg ascorbic acid 100 mL^{-1}) from pitombas stored in packages at different temperatures (6, 8, 10, 12, and 14 °C) for 12 days.



Source: Authors.

According to Brackmann *et al.* (2011), the decrease in vitamin C is directly related to temperature, which accelerates its loss because it is sensitive to physicochemical agents such as light, oxygen, and heat.

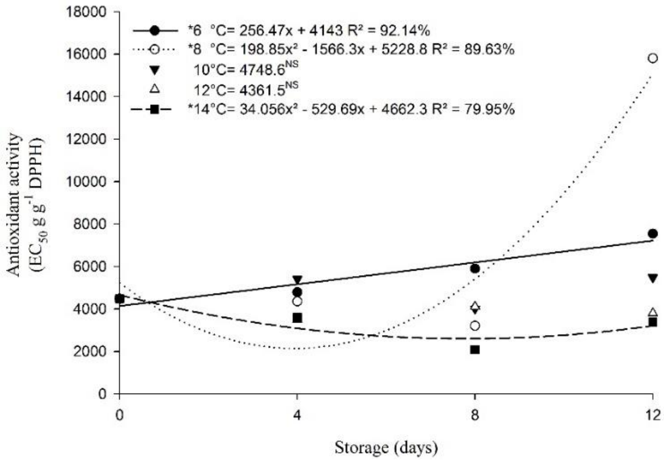
Regarding the contents of total extractable polyphenols, a mean value of 110.62 mg GAE 100 g^{-1} was found for fruits stored at 6 °C and packed in LDPE, not differing statistically from the other packages (Table 5). In addition, polyphenol contents gradually increased as temperature increased, standing out the PP packaging associated with the temperature of 14 °C, responsible for the highest mean (181.03 mg GAE 100 g^{-1}). Edusei; Ofosu-Anim (2013) worked with green peppers packaged in PP packaging and also observed increases in polyphenols with increasing temperature.

The means of days within each package showed an increase in the total extractable polyphenols during storage (Table 5) but followed by a decrease, except only for the PET packaging, which showed an increase from the 1st to the 12th day, with the highest significant mean. PET packaging also stood out at ambient temperature (25 ± 2 °C) with the highest mean at the end of the 8th day (Table 1).

These results point out to higher amounts of polyphenols than fruits usually known for their functional power, such as kiwi (98.41 mg GAE 100 g^{-1}), nectarine (28.78 mg GAE 100 g^{-1}), mango (34.71 mg GAE 100 g^{-1}), strawberry (107.30 mg GAE 100 g^{-1}) (MACHADO *et al.*, 2013), cajá (72.00 mg GAE 100 g^{-1}), and cashew (118.00 mg GAE 100 g^{-1}) (RUFINO *et al.*, 2010). According to Silva *et al.* (2018), it makes pitomba consumption interesting, mainly in its fresh form, preserving the antioxidant potential through the inhibition of free radicals.

Pitombas stored at temperatures of 12 and 14 °C showed an increase in polyphenol contents up to the 8th day, with a subsequent decrease until the 12th day, standing out fruits stored at 14 °C, with the highest contents over the experimental period (mean of 114.63 mg GAE 100 g^{-1} on the 1st day, followed by 171.51 mg GAE 100 g^{-1} on the 8th day, and 153.55 mg GAE 100 g^{-1} at the end storage) (Figure 5). According to Daiuto *et al.* (2010), this increase during storage may be associated with fruit weight loss, concentrating on these substances.

Figure 5 - Total antioxidant activity (EC50 g g^{-1} DPPH) of pitombas stored in packages at different temperatures (6, 8, 10, 12, and 14 °C) for 12 days.



Source: Authors.

The reduction observed in total extractable polyphenols, according to Yang *et al.* (2011), may have occurred as a result of its oxidation, which reduced its concentration in the fruits. Antioxidant activity is represented by the ability to slow the rate of oxidative reactions, such as the inhibition of free radicals. However, Santos *et al.* (2013) mentioned that a low EC50 value has a high potential to sequester free radicals in the sample.

The lowest temperatures (6 and 8 °C) were responsible for presenting the highest means of this parameter, increasing for the control package associated with a temperature of 6 °C, with a mean of 9002.94 EC50 g g^{-1} DPPH, differing statistically from the other packages (Table 6). However, the lowest values for this parameter, i.e., high antioxidant activity, were observed at the highest temperatures (12 and 14 °C), standing out mainly the temperature of 14 °C associated with PET and PVC+EPS packages (2405.07 and 2695.35 EC50 g g^{-1} DPPH, respectively).

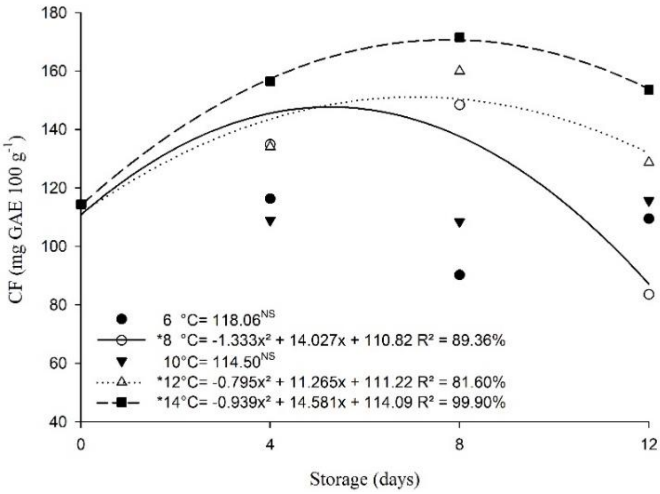
The PET and PVC+EPS packages at

ambient temperature (25 ± 2 °C) also provided to fruits high capacity to react with 50% of the radical present in the DPPH solution (Table 1), showing the lowest means (2597.00 and 3246.00 EC50 g g^{-1} DPPH, respectively) and promote a high maintenance of this parameter.

An increase in the mean values of total antioxidant activity was observed during storage for all treatments (Table 6), standing out the PP and LDPE packages and WP (control) on the 12th day, with the highest means compared to the 1st day of analysis, which showed no significant difference from each other. The PVC+EPS packaging had the lowest means during the 12 days, showing the lowest value on the 8th day (2277.45 EC50 g g^{-1} DPPH) compared to the other polymers.

Pitombas stored at 6 °C had a low linear increase (Figure 5), while the quadratic behavior was observed for temperatures of 8 and 14 °C, decreasing up to the 4th and 8th days, respectively, with subsequent increase up to the 12th day at both temperatures (8 and 14 °C). In this sense, the temperature of 14 °C stood out for promoting the highest contents of total extractable polyphenols (Figure 4) and high antioxidant power, with a mean of 3391.32 EC50 g g^{-1} DPPH. Vieites *et al.* (2011) studied jabuticaba for 30 days and observed that temperatures of 0, 3, and 6 °C showed lower antioxidant activities than higher temperatures, a behavior similar to that observed in this experiment.

Figure 4 - Content of total extractable polyphenols (CF - mg GAE 100 g^{-1}) of pitombas stored in packages at different temperatures (6, 8, 10, 12, and 14 °C) for 12 days.



Source: Authors.

Table 4 - Ascorbic acid contents (mg ascorbic acid 100 mL^{-1}) of pitombas stored at different temperatures (6, 8, 10, 12, and 14 °C) for 12 days in polypropylene (PP), low-density polyethylene (LDPE), polyethylene terephthalate (PET), polyvinyl chloride (PVC) packages and without packaging (WP).

Temperature	Packaging				
	PP	LDPE	PET	PVC+EPS	WP
6 °C	[1]0.76 Cb	0.89 Ca	0.87 Ba	0.96 Ba	0.92 Aa
8 °C	1.05 Aa	0.96 Ba	1.01 Aa	0.92 Ba	0.98 Aa
10 °C	0.92 Bb	1.08 Aa	0.91 Bb	1.08 Aa	0.91 Ab
12 °C	0.86 Ca	0.84 Ca	0.91 Ba	0.96 Ba	0.80 Ba
14 °C	0.82 Ca	0.84 Ca	0.81 Ba	0.84 Ca	0.79 Ba
Day					
0	1.05 Aa	1.05 Aa	1.05 Aa	1.05 Aa	1.05 Aa
4	0.85 Ba	0.81 Ca	0.79 Ca	0.85 Ba	0.80 Ca
8	0.75 Cb	0.89 Ba	0.92 Ba	0.99 Aa	0.92 Ba
12	0.87 Ba	0.94 Ba	0.84 Cb	0.90 Ba	0.79 Cb

[1]Means followed by the same lowercase letter in the row (comparing means of packages for each temperature and day of analysis) and uppercase letter in the column (comparing means of temperatures and days of analysis for each package) do not differ significantly from each other (p>0.05) by the Scott-Knott test.
Source: Authors.

Table 5 - Content of total extractable polyphenols (mg GAE 100 g^{-1}) of pitombas stored at different temperatures (6, 8, 10, 12, and 14 °C) for 12 days in polypropylene (PP), low-density polyethylene (LDPE), polyethylene terephthalate (PET), and polyvinyl chloride (PVC) packages and without packaging (WP).

Temperature	Packaging				
	PP	LDPE	PET	PVC+EPS	WP
6 °C	[1]110.42 Ca	110.62 Aa	109.41 Ba	104.19 Ca	103.51 Ca
8 °C	122.14 Ca	97.00 Ab	108.97 Bb	131.89 Ba	141.59 Ba
10 °C	117.57 Ca	103.46 Ab	114.80 Ba	124.62 Ba	98.85 Cb
12 °C	148.50 Bb	118.81 Ac	124.66 Bc	163.84 Aa	115.66 Cc
14 °C	181.03 Aa	109.97 Ac	155.63 Ab	150.55 Ab	147.75 Ab
Day					
0	114.38 Ba	114.38 Aa	114.38 Ba	114.38 Ca	114.38 Ba
4	150.22 Aa	120.39 Ab	117.67 Bb	134.63 Bb	121.77 Bb
8	160.13 Aa	96.45 Bd	123.79 Bc	171.61 Aa	132.74 Ab
12	118.99 Bc	100.67 Bc	134.94 Aa	119.46 Cb	116.99 Bb

[1]Means followed by the same lowercase letter in the row (comparing means of packages for each temperature and day of analysis) and uppercase letter in the column (comparing means of temperatures and days of analysis for each package) do not differ significantly from each other (p>0.05) by the Scott-Knott test.
Source: Authors.

Table 6 - Total antioxidant activity (EC_{50} g g^{-1} DPPH) of pitombas stored at different temperatures (6, 8, 10, 12, and 14 °C) for 12 days in polypropylene (PP), low-density polyethylene (LDPE), polyethylene terephthalate (PET), and polyvinyl chloride (PVC) packages and without packaging (WP).

Temperature	Packaging				
	PP	LDPE	PET	PVC+EPS	WP
6 °C	[1]4647.24 Bb	5132.74 Bb	4741.20 Bb	4884.90 Ab	9002.94 Aa
8 °C	8659.24 Aa	7912.69 Aa	8224.78 Aa	4528.78 Ac	5508.59 Cb
10 °C	3825.59 Cd	5350.87 Bb	4728.56 Bc	4053.47 Ad	6287.85 Ba
12 °C	3763.51 Ca	4485.92 Ca	4538.92 Ba	2986.03 Bb	4095.86 Da
14 °C	4361.59 Ba	3767.97 Ca	2405.07 Cb	2695.35 Bb	3726.60 Da
Day					
0	4490.30 Ba	4490.30 Ba	4490.30 Ba	4490.30 Ba	4490.30 Ca
4	4672.18 Bb	4201.43 Bc	4062.31 Bc	3299.64 Cd	5214.19 Ba
8	3218.34 Cb	4629.15 Ba	4298.96 Ba	2277.45 Dc	4907.38 Ca
12	7824.90 Aa	7999.27 Aa	6859.26 Ab	5451.43 Ac	8085.60 Aa

[1]Means followed by the same lowercase letter in the row (comparing means of packages for each temperature and day of analysis) and uppercase letter in the column (comparing means of temperatures and days of analysis for each package) do not differ significantly from each other (p>0.05) by the Scott-Knott test.
Source: Authors.

4. CONCLUSIONS

The combined effect of storage at 6 °C associated with the LDPE packaging can be recommended for pitomba storage for 12 days, as it presents low weight loss. In addition, the temperature of 14 °C can also be used, as fruits showed high values of bioactive compounds.

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