

Application of Coverings and Storage at Different Temperatures on Dragon fruits (*Hylocereus undatus*)

ABSTRACT

Aims: This study aimed at evaluating the physicochemical characteristics of dragon fruits with application of different types of covering and submitted to two different refrigeration temperatures.

Study design: The dragon fruits were taken, selected, washed, cleaned with a solution of Sodium hypochlorite 1%, dried and then, treated with coverings based on manioc starch at 2%, a jelly solution at 2% and a conservative solution (1% of ascorbic acid, 0.5% of citric acid, 0.7% of sodium chloride and 0.25% of calcium chloride) by immersion during 2 minutes. There was also a control treatment, that is, without treatment. After applying the coverings and drying the fruits, they were stored under refrigeration ($8^{\circ}\text{C} \pm 1^{\circ}\text{C}$ and $13^{\circ}\text{C} \pm 1^{\circ}\text{C}$) and evaluated every 5 days, during 25 days of storage. The analyses carried out during the storage time were: pH, titratable acidity, soluble solids, ratio (SS/TA), coloration of pulp (parameters L^* , C^* and $^{\circ}\text{Hue}$) and mass loss.

Place and Duration of Study: Laboratory of Food Biochemistry / State University of Maringá, in February 2013.

Methodology: Results: The fruits treated with jelly coverings and conservative solutions had the best appearance during storage under refrigeration at 8°C . The parameters we evaluated showed oscillations in the average values, according to the period of time; however, there was not influence among the treatments.

Conclusion: It was possible to maintain the quality of fruits for longer periods with the application of coverings together with refrigeration temperatures.

Keywords: Post-harvest. Coverings. Conservation. Quality.

1. INTRODUCTION

Dragon fruit is a cactus that belongs to genus *Hylocereus* and is native to the Americas [1, 25]. This fruit comes from Tropical and Subtropical America and belongs to the group of fruit trees that are considered promising for cultivation [2].

A few decades ago, these plants were unknown; however, currently, they occupy a growing niche in the market of exotic fruits in Europe and have been searched for, not only due to its exotic appearance, but also because of its sensorial features [3].

They take part in one of the families of cactus that are easily recognized, with approximately 1600 species, being that more than 70% occur in xeric and semi-arid areas. Out of this number of species, approximately 130 are epiphytes that can be found in Neotropical forests and woods [4]. Fruits like dragon fruit and others, have significant levels of postharvest loss.

In developing or emergent countries, postharvest losses of all kinds of food can reach about 30% or more in production [5, 24]. Therefore, maintaining fruit quality is essential, using

postharvest storage techniques that tend to reduce respiratory rates, retard ripening and prevent physiological disorders. Water loss and natural decomposition of the fruit can be reduced in lower temperatures and also by changing the room environment, or even both, right after harvest [6].

Together with these factors, other strategies for postharvest improvement and quality control of fruits and vegetables, we can cite the application of Systems of Quality Guaranty, such as Good Agricultural Practices, Good Manufacture Practices, refrigeration and the use of coverings, whether edible or not [7].

Given the above, this study aimed at evaluating physicochemical characteristics of dragon fruits (*Hylocereus undatus*) during storage, with the application of coverings and different refrigeration temperatures.

2. MATERIAL AND METHODS

The fruits were harvested 45 days after fecundation in a rural property located in the city of Marialva, Paraná, Brazil, in February (crop 2013). The fruits were harvested randomly, conditioned in boxes made of industrial fiber. Later, they were taken to the Laboratory of Food Biochemistry of State University of Maringá (UEM), where they went through a selective process (fruits with physiological disorders and mechanical damages were removed), washing with neutral detergent, cleaning with solution of sodium hypochlorite 1% and drying with the aid of ventilation.

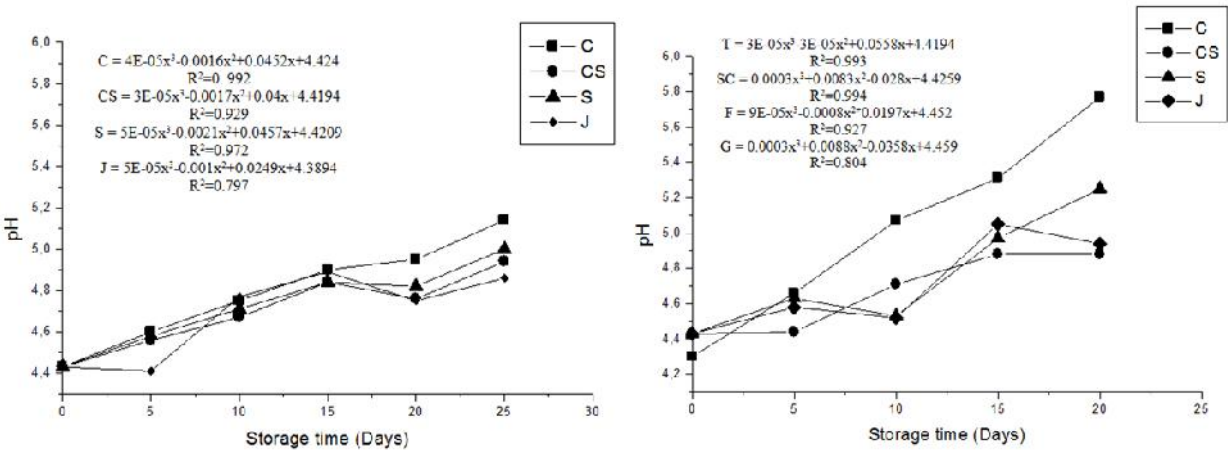
After being dried, the fruits were divided into four groups and submitted to four different coverings: (1) Control (T); (2) Solution with manioc starch at 2% (F); (3) Solution with jelly at 2% (J) and (4) Conservative Solution (SC) (1% of ascorbic acid, 0.5% of citric acid, 0.7% of sodium chloride and 0.25% of calcium chloride) [8]. After immersing the fruits into these solutions for 2 minutes, they were placed in trays with porous surfaces, where they remained until the coverings were completely dried and then, stored without packages under refrigeration temperatures. All of the treated fruits were divided into two groups: the first one being stored under refrigeration at $8^{\circ}\text{C} \pm 1^{\circ}\text{C}$ (T1) - (maximum of 85% and minimum of 34% of relative humidity) and $13^{\circ}\text{C} \pm 1^{\circ}\text{C}$ (T2) - (maximum of 65% and minimum of 46% of relative humidity). The fruits remained in storage for 25 days and were analyzed every 5 days.

The physicochemical analyses we carried out were: pH (determined by direct reading – potentiometric process - in pHmeter Hanna Instruments - Model HI 221 [9]; titratable acidity (TA) by titration with solution of NaOH 0.1M standardized and expressed in percentage (%) of organic acid [10]; soluble solids (SS), determined by digital refractometer (Pocket) PAL-1, brand ATAGO, expressed in °Brix [9]; Ratio SS/TA, determined from the ratio between soluble solids and titratable acidity [10]; mass loss, made by the difference between initial and final weights in analytical scale BEL Engineering and expressed in percentage (%) [11] and pulp coloration, determined by colorimeter model CR-10, brand Konica Minolta, where we analyzed parameters L^* , C^* and °Hue [12].

The experimental design was in random blocks, in triplicates, and the data we obtained were submitted to Analysis of Variance (ANOVA). We also applied Tukey test to the averages at 5% of probability ($P < 0.05$), by means of the statistical software Sisvar [13].

82 **3. RESULTS AND DISCUSSION**

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84 For pH analysis, all of the fruits from the four different treatments (control,
85 conservative solution, starch and jelly) and both temperatures ($8^{\circ}\text{C} \pm 1^{\circ}\text{C}$, $13^{\circ}\text{C} \pm 1^{\circ}\text{C}$) had
86 average results ranging between 4.41 and 5.77. However, during storage period, it was
87 possible to observe a slight increase in these averages, for all treatments, as it is shown in
88 Figure 1.



89 **Fig 1. pH values of pulp of dragon fruit (*Hylocereus undatus*) with coverings during**
90 **storage under refrigeration temperatures of $8^{\circ}\text{C} \pm 1^{\circ}\text{C}$ (a) and $13^{\circ}\text{C} \pm 1^{\circ}\text{C}$ (b).**
91 **Treatments: (C = Control; CS = Conservative Solution; S = Starch and J = Jelly).**

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93 Studies with dragon fruit had initial average values for pH of 4.60 and, on the last days of
94 storage, averages between 5.32 and 5.80 for refrigerated fruits [14]. For three dragon fruit
95 cultivars, had average pH values between 4.30 and 4.70 [15], and medias 4.75 to 4.91[16];
96 these results are in accordance with the ones we obtained, which highlights that, most likely,
97 the treatments did not affect pH during storage.
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100 As for titratable acidity (TA) (Figure 2), the averages decreased during storage time, for all
101 temperatures and coverings. Despite some minor variations among the treatments, it was
102 not possible to notice that there was difference in acidity due to the treatments (temperature
103 and coverings). The results obtained for acidity agree with pH average values, because as
104 organic acid amounts decrease, the concentration of H^+ also decreases in the pulp, which
105 contributes to this raise in pH.
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107 In general, the content of organic acid diminished as the fruits ripened, due to their use as
108 substrate for respiratory processes or to convert to sugars [5]. Obtained average values for
109 acidity of dragon fruit pulp between 1.85% and 0.17% of citric acid / 100g of pulp [14], which
110 were similar to the results found in this study. Other values for titratable acidity of two
111 different breeds of dragon fruit: 0.35 to 0.45% of malic acid / 100g of pulp [17]. While
112 studying juice of two varieties of dragon fruit (*Hylocereus polyrhizus* and *Hylocereus*
113 *undatus*), [18] obtained 3.40% and 3.30% of malic acid, respectively.
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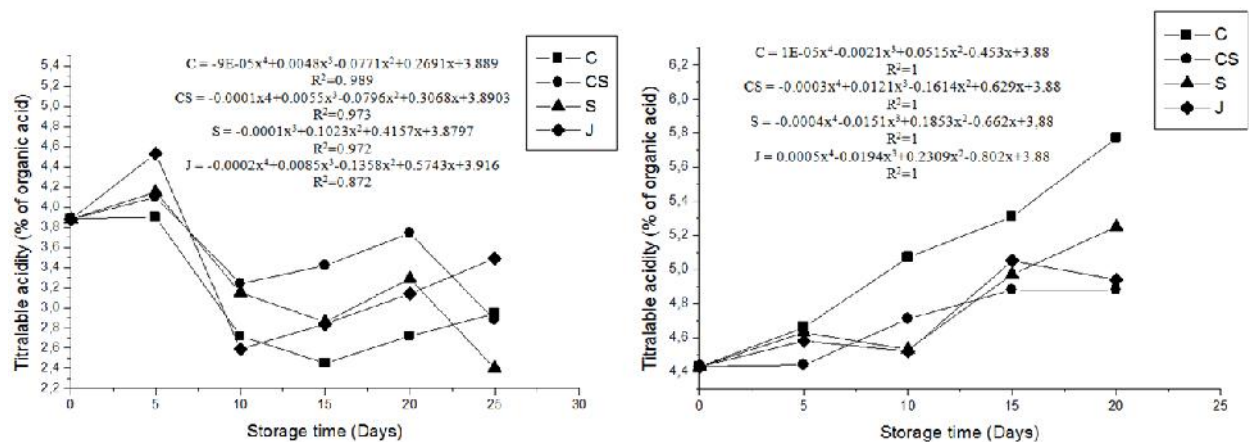


Fig 2. Titratable acidity (% of organic acid) of dragon fruit (*Hylocereus undatus*) pulp with coverings during storage under refrigeration temperatures of 8°C ± 1°C (a) and 13°C ± 1°C (b). Treatments: (C = Control; CS = Conservative Solution; S = Starch and J = Jelly).

The average values for soluble solids have variations among the coverings and the refrigeration temperatures (Figure 3), but both demonstrate a drop during the last storage days. With respect to the coverings, they did not present uniformity during the days of analysis. The numbers varied between 10.80°Brix and 15.73°Brix among all of the treatments.

Soluble solids indicate the amount, in grams, of solids dissolved in juice or pulp of fruits, and they usually grow, as fruits ripen [5].

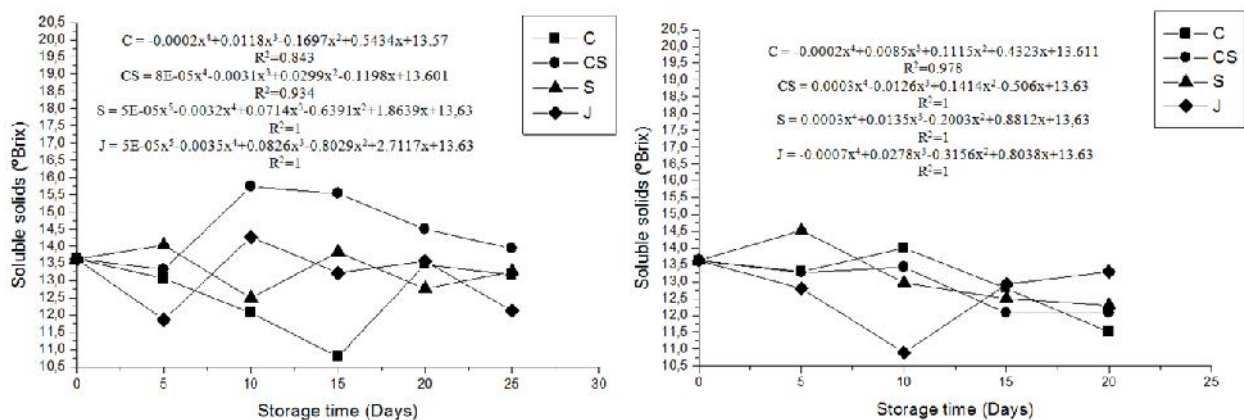


Fig 3. Soluble solids (°Brix) of dragon fruit (*Hylocereus undatus*) pulp with coverings during storage under refrigeration temperatures of 8°C ± 1°C (a) and 13°C ± 1°C (b). Treatments: (C = Control; CS = Conservative Solution; S = Starch and J = Jelly).

In this study, we did not observe raises in the content of soluble solids. Since dragon fruit is considered a non-climacteric fruits [19], there may not be an increase in the amount of

soluble solids in its pulp, because non-climacteric fruits usually only ripens fully when it is on the plant, that is, there is no increase in dissolved solids in the fruit pulp [5]. On the other hand, researches cite that fruits can be harvested at once, because they tend to ripen after harvest and be preserved for a longer time [1].

Values slightly lower for soluble solids were found in other studies, but with the same behavior of averages, in which case, the dragon fruits had 11.50°Brix at initial time and, at the end of storage, for temperatures of 18°C, 13°C and 8°C, the averages were 8.52, 8.72 and 10.90°Brix, respectively [14]. For commercial dragon fruit, found 8.00°Brix and for a variety from Cerrado, 13.50°Brix [20].

Ratio soluble solids / titratable acidity is one of the means used to evaluate fruit flavor, being more representative than measuring acidity and amount of sugars [5]. This ratio is used as an indicator for the maturation degree of the raw-material [10], i.e., the higher this ratio, the higher the maturation degree and the better the taste. This relation for temperatures T1 and T2 (Figure 4) demonstrated an independent increase of coverings during storage.

Other authors noticed an increase in this ratio soluble solids / titratable acidity in grapes 'Italia', treated with sodium alginate and stored under refrigeration, resulting in quality fruits with pleasant flavor [21].

Regarding mass loss (%) (Figure 5), in all coverings, both temperatures had an increase during storage days, when the values varied from 2.44 to 4.67% on the first day of analysis, and from 7.59 to 14.27% on the last days of analysis

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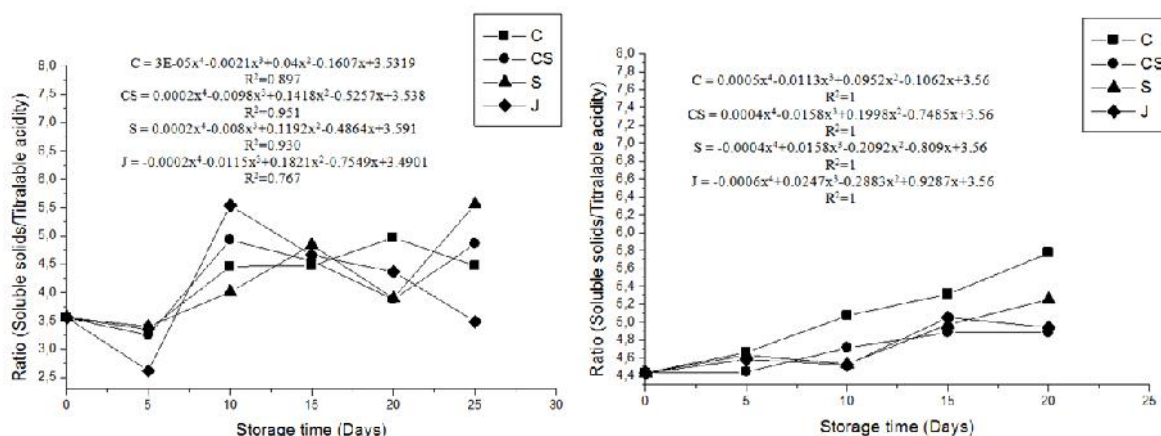


Fig 4. Ratio (Soluble Solids / Titratable Acidity) of dragon fruit (*Hylocereus undatus*) pulp with coverings during storage under refrigeration temperatures of 8°C ± 1°C (a) and 13°C ± 1°C (b). Treatments: (T = Control; SC = Conservative Solution; F = Starch and G = Jelly).

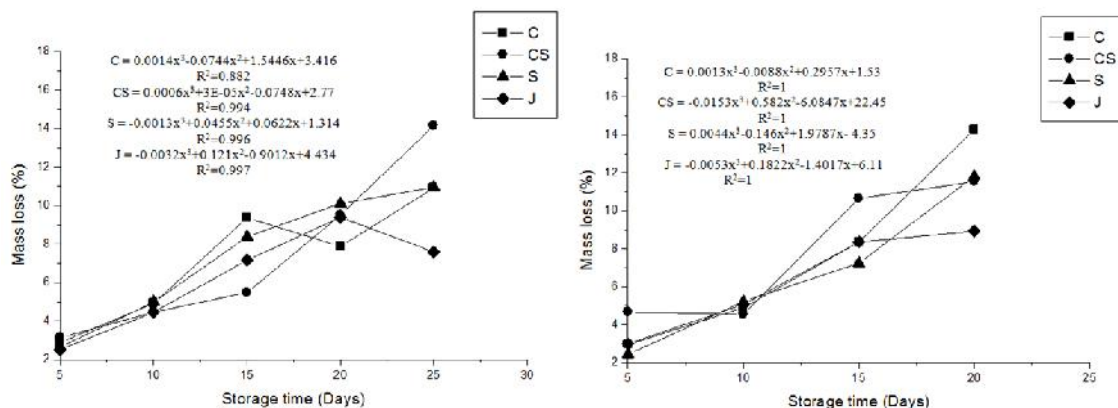


Fig 5. Mass loss (%) of dragon fruit (*Hylocereus undatus*) pulp with coverings during storage under refrigeration temperatures of 8°C ± 1°C (a) and 13°C ± 1°C (b). Treatments: (T = Control; SC = Conservative Solution; F = Starch and G = Jelly).

The main cause for mass loss in fruits and vegetables is water loss through transpiration, which give origin to important morphological alterations, unchaining alterations in color and texture of the fruit. These losses, when they reach 3% to 6%, are considered enough prejudicial to fruit quality [5]. In studies carried out with red dragon fruit, during storage for 25 days, under refrigeration (13°C and 8°C), the author obtained crescent averages of mass loss, which varied from 2.73% to 7.82% and from 2.35% to 5.32%, respectively [14]. A similar behavior was found in this study, increasing mass loss throughout the days of analysis.

Organic fruits of *Vaccinium ashei* Reade (Blueberry), treated with edible coverings based on manioc starch [11], did not show differences among the treatments. However, studies that evaluated the effect of coverings based on jelly at 20% on tomatoes stored for seven days at 23°C showed that the fruits had a higher mass loss, when compared to the control treatment, which is a different result from this study, in which jelly coverings had the lowest mass loss during storage [22].

For coloration of dragon fruit pulp, we evaluated three parameters: L*, C* and °Hue. The evaluation of fruit color is an important parameter for producers and consumers, given that, through this feature, one can see whether the fruit reached ideal conditions for commercialization or not [23].

For parameter L* (Table 1), which measures luminosity, there were some oscillations during storage. There was a slight increase in values, indicating that luminosity was intensified in the fruit. It is important to highlight that on the fifth day of evaluation, for temperature 13°C, the values were different from the other days.

Results found for parameter C* of pulp (Table 2) had crescent averages during storage, in spite of some variations among the values, pointing out the intensification of the most vivid colors. As for values of °Hue, we did not observe great differences between the days of analysis and the treatments (Table 3), that is, the numbers were constant during storage.

207 **Table 1. Average values of coloration of dragon fruit (*Hylocereus undatus*) pulp**
 208 **(Parameter L*) during storage with coverings and under refrigeration at 8°C (T1) and**
 209 **13°C (T2). (n=3)**

L*				
T1				
Time	Control	Solution	Starch	Jelly
0	43.67±2.42cA	43.67±2.42bA	43.67±2.42cA	43.67±2.42bA
5	46.72±6.89bcA	44.17±0.49bA	46.67±3.20bcA	43.92±3.54bA
10	56.41±3.67aA	52.82±1.94aA	50.72±5.05abcA	53.65±4.30aA
15	50.80±1.82abcA	54.80±6.75aA	53.45±3.47abA	57.97±2.16aA
20	50.90±3.62abcA	57.22±1.91aA	55.10±5.79aA	55.57±6.61aA
25	54.10±4.20abA **	57.97±6.00aA	51.92±3.23abA	53.65±1.81aA
CV(%) ¹	7.63			
T2				
Time	Control	Solution	Starch	Jelly
0	43.67±2.42bA	43.67±2.42bA	43.67±2.42bA	43.67±2.42bA
5	23.95±0.97cAB	26.17±2.18cA	23.32±2.82cAB	20.85±2.95cB
10	52.80±1.52aA	52.97±2.52aA	48.87±4.21abAB	45.70±2.20bB
15	53.30±3.87aA	47.30±4.71bB	46.65±1.86abB	54.50±4.16aA
20	53.00±1.04aA **	54.00±1.40aA	51.85±1.98aA **	53.42±1.97aA
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CV(%) ¹	6.01			

210 *n = number of repetitions. *Different lowercase letters in the same column have significant differences
 211 between them by Tukey test (p<0.05). *Different capitalized letters in the same line and in the same
 212 temperature have significant differences between them, by Tukey test (p<0.05). cv(%)¹ = Coefficient of
 213 variation in percentage. (**) = Fruits with presence of physiological disorders. (...) = Treatments
 214 discarded due to rotten fruits.

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 216 In studies that determined color parameters in juices made of different types of Cactaceae,
 217 which is the family to which dragon fruit belongs, the genus *Opuntia* (*Opuntia ficus-indica*)
 218 was evaluated as for parameters L*, C* and °Hue in different pH. For values of L*, as pH
 219 increased, L* increased as well. This result is coherent to this study, because in pH
 220 evaluations it is possible to observe that it slightly increased during storage of fruits. As for
 221 parameters C* and °Hue in juice of three types of cactus with crescent pH concentrations,
 222 there were not different values for C* and °Hue in *Opuntia ficus-indica* cv. 'Rossa' and
 223 *Hylocereus polyrhizus* [18].

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 225 In this study, the increase in pH during storage time did not influence an increase or
 226 decrease of average numbers for °Hue, but for C*, we did not observe stable data.

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238 **Table 2. Average values of coloration of dragon fruit (*Hylocereus undatus*) pulp**
 239 **(Parameter C*) during storage with coverings and under refrigeration at 8°C (T1) and**
 240 **13°C (T2). (n=3)**

C*				
T1				
Time	Control	Solution	Starch	Jelly
0	6.77±0.85aA	6.77±0.85bA	6.77±0.85abA	6.77±0.85abA
5	7.65±1.12aA	6.60±0.40bAB	5.80±0.82bB	6.22±0.55bB
10	7.87±0.57aA	7.35±0.50abA	6.95±0.51abA	7.87±0.66aA
15	7.20±0.33aA	7.62±0.77abA	7.15±0.45abA	7.55±0.34abA
20	7.60±0.91aA	8.57±0.55aA	7.90±0.47abA	7.75±1.10aA
25	7.85±1.16aA **	8.05±0.46abA	7.82±0.40aA	7.80±0.55aA
CV(%) ¹	9.72			
T2				
Time	Control	Solution	Starch	Jelly
0	6.77±0.85aA	6.77±0.85abA	6.77±0.85aA	6.77±0.85abA
5	4.50±1.04bA	5.70±1.04bA	6.07±0.95aA	5.92±3.14bA
10	7.77±0.83aA	7.97±0.48aA	7.02±1.22aA	6.47±0.32bA
15	8.55±1.39aA	6.87±0.79abAB	6.10±0.48aB	7.85±1.05abAB
20	8.10±0.46aA **	8.17±0.30aA	8.00±0.53aA **	8.17±0.83aA
25	...	...	...	...
CV(%) ¹	15.53			

241 *n = number of repetitions. *Different lowercase letters in the same column have significant differences
 242 between them by Tukey test (p<0.05). *Different capitalized letters in the same line and in the same
 243 temperature have significant differences between them, by Tukey test (p<0.05). cv(%)¹ = Coefficient of
 244 variation in percentage. (**) = Fruits with presence of physiological disorders. (...) = Treatments
 245 discarded due to rotten fruits.

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 248 Although the coverings exercised little influence on some parameters, such as pH, soluble
 249 solids and mass loss, they did not exercise such great influence on the other analyses.
 250 According to the results, coverings based on conservative solution and jelly were the ones
 251 that had the best appearance and quality of fruits during storage, guaranteeing fruits
 252 adequate for consumption for a longer period.

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Table 3. Average values of coloration of dragon fruit (*Hylocereus undatus*) pulp (Parameter °Hue) during storage with coverings and under refrigeration at 8°C (T1) and 13°C (T2). (n=3)

°Hue				
T1				
Time	Control	Solution	Starch	Jelly
0	95.50±1.65aA	95.50±1.65aA	95.50±1.65aA	95.50±1.65aA
5	87.80±3.18bB	92.60±2.91aAB	95.16±3.02aA	91.02±2.03abcAB
10	88.35±3.92bA	90.67±1.84aA	90.05±3.06abA	85.42±3.91cA
15	88.30±7.69bA	91.25±3.95aA	91.47±0.80abA	90.15±1.09abcA
20	88.17±3.95bA	91.72±4.82aA	92.17±1.99abA	92.15±1.73abA
25	95.62±3.47aA**	92.27±1.69aAB	88.00±2.60bB	87.72±1.54bcB
CV(%) ¹	3.31			
T2				
Time	Control	Solution	Starch	Jelly
0	95.50±1.65aA	95.50±1.65abA	95.50±1.65abA	95.50±1.65abA
5	94.22±5.57abB	103.75±8.25aA	100.90±6.89aAB	101.67±7.11aAB
10	90.90±2.67abA	85.15±3.41cA	91.60±4.83bA	90.20±6.55bA
15	85.87±2.22bA	90.12±3.35bcA	90.90±5.41bA	89.62±2.37bA
20	92.05±0.75abA **	88.65±1.73bcA	89.67±1.73bA**	87.62±4.01bA
25	...	...	...	...
CV(%) ¹	4.68			

*n = number of repetitions. *Different lowercase letters in the same column have significant differences between them by Tukey test (p<0.05). *Different capitalized letters in the same line and in the same temperature have significant differences between them, by Tukey test (p<0.05). cv(%)¹ = Coefficient of variation in percentage. (**) = Fruits with presence of physiological disorders. (...) = Treatments discarded due to rotten fruits.

4. CONCLUSION

The coverings we applied to dragon fruits were efficient, as for fruit conservation and appearance. Thus, the application of coverings and refrigeration temperature of 8°C proportionated longer shelf life and maintained fruit quality, allowing longer period for commercialization.

5. CONFLICT OF INTEREST

There are no conflict of interest.

REFERENCES

- Marques V B, Moreira R A, Ramos J D, Araújo N A, Silva F O R. Fenologia reprodutiva de pitaia vermelha no município de Lavras, MG. 2011; 41(6): 984-987.
- Moreira R A, Ramos J D, Marques V B, Araújo N A, Melo P C. Crescimento de pitaia vermelha com adubação orgânica e granulada bioclástico. Ciência Rural. 2011; 41(5):785-788.
- Le Bellec F, Vaillant F, Imbert E. Pitahaya (*Hylocereus* spp.): a new crop, a market with a future. Fruits. 2006; 61(4): 237-250.
- Wallace R S, Gibson A C. Evolution and systematic. In: Cacti, Biology and uses. Nobel, P. (Editor). California: University of California Press, 2002.

- 300 5. Chitarra M I F, Chitarra A B. Pós-colheita de frutos e hortaliças: fisiologia e
301 manuseio. 2th Ed. Lavras: UFLA, 2005.
- 302 6. Souza J P, Praça E F, Alves R E, Neto F B, Dantas F F. Influência do
303 armazenamento refrigerado em associação com atmosfera modificada por filmes
304 plásticos na qualidade de mangas "Tommy Atkins". Revista Brasileira de
305 Fruticultura. 2002; 24(3): 665-668.
- 306 7. Cenci S A. Boas Práticas de Pós-colheita de Frutas e Hortaliças na Agricultura
307 Familiar. In: Fenelon do Nascimento Neto. (Org.). Recomendações Básicas para a
308 Aplicação das Boas Práticas Agropecuárias e de Fabricação na Agricultura Familiar.
309 1th ed. Brasília: Embrapa Informação Tecnológica, 2006; 67-80.
- 310 8. Fontes L C B, Sarmento S B S, Spoto M H F, Dias C T S. Conservação de maça
311 minimamente processada com uso de películas comestíveis. Ciência e Tecnologia
312 de Alimentos. 2008; 28(4):871-880.
- 313 9. A.O.A.C. Association of Official analytical Chemists. Official methods of analysis.
314 16th ed. Gaithersburg: Published by AOAC International. v.2, 1997.
- 315 10. Lutz, A. Métodos físico-químicos para análise de alimentos. 1th ed. São Paulo;
316 2005.
- 317 11. Stülp M, Clemente E, Oliveira D M, Gnás B B B. Conservação e qualidade de mirtilo
318 orgânico utilizando revestimento comestível a base de fécula de mandioca. Revista
319 Brasileira de Tecnologia Agroindustrial. 2012; 6(1): 713-721.
- 320 12. Castro J C, Marsolla D A, Kohatsu D S, Hora R C. Armazenamento e qualidade de
321 frutos de mangueira (*Mangifera indica* L.) tratados com ácido giberélico. Journal of
322 Agronomic Sciences. 2012;1(1):76-83.
- 323 13. Ferreira D F. Manual do sistema Sisvar para análises estatísticas. Lavras: UFLA,
324 2008.
- 325 14. Brunini M A, Cardoso S S. Qualidade de pitaias de polpa branca armazenadas em
326 diferentes temperaturas. Revista Caatinga. 2011; 24(3):78-84.
- 327 15. Vaillant F, Perez A, Davila I, Dornier M, Reynes M. Colorant and antioxidant
328 properties of red purple pitahaya (*Hylocereus* sp.). Fruits. 2005; 60: 3-12.
- 329 16. Fernandes L M S, Vieties R L, Cerqueira R C, Braga C L, Surtoli L F, Amaral J L.
330 Características pós-colheita em frutos de pitaya orgânica submetida a diferentes
331 doses de irradiação. Revista Biodiversidade. 2010; 9(1).
- 332 17. Silva A C C, Martins A B G, Cavallari L L. Qualidade de frutos de pitaya em função
333 da época de polinização, da fonte de pólen e da coloração da cobertura. Revista
334 Brasileira de Fruticultura. 2011; 33(4): 1162-1168.
- 335 18. Stintzing F C, Schieber A, Carle R. Evaluation of color properties and chemical
336 quality parameters of cactus juices. European Food Research and Technology.
337 2003; 216(4):303-311.
- 338 19. Zee F, Yen C, Nishina M. Pitaya (Dragon fruit, Strawberry pear). Cooperative
339 extension Service. Fruits and Nuts. 2004.
- 340 20. Lima C A, Faleiro F G, Junqueira N T V, Cohen K O, Guimarães T G.
341 Características físico-químicas, polifenóis e flavonoides amarelos em frutos de
342 espécies de pitaias comerciais e nativas do cerrado. Revista Brasileira de
343 Fruticultura. 2013; 35(2): 565-570.
- 344 21. Miguel A C A, Dias J R P S, Albertini S, Spoto M H F. Pós-colheita de uva 'Itália'
345 revestida com filmes à base de alginato de sódio e armazenada sob refrigeração.
346 Ciência e Tecnologia de Alimentos. 2009;29(2): 277-282.
- 347 22. Oliveira T A, Leite R H L, Aroucha, E M M, Ferreira R M A. Efeito do revestimento
348 de tomate com biofilme na aparência e perda de massa durante o armazenamento.
349 Revista Verde. 2011; 6(1): 230-234.
- 350 23. Reis K C, Siqueira H H, Alves A P, Silva J D, Lima L C O. Efeito de diferentes
351 sanificantes sobre a qualidade de morango cv. Oso Grande. Ciência e Tecnologia
352 de Alimentos. 2008; 32(1): 196-202.

- 353 24. Fao. Global food losses and food waste: Extent, causes and prevention. Rome,
354 2011.
- 355 25. Rebecca O P S, Boyce A N, Chandran S. Pigment identification and antioxidant
356 properties of red dragon fruit (*Hylocereus polyrhizus*). 2010; 9(10): 1450-1454.
357