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Quality of peach palm heart minimally processed

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Abstract

The peach palm heart is a hypocaloric gourmet vegetable, rich in fiber and minerals such as potassium, calcium, and magnesium, and it can be incorporated into calorie restriction diets. Minimum processing consists of sanitizing and cutting the products before reaching the consumer, providing convenience to consumption without losing its quality, thus resulting in sufficient shelf life for distribution and marketing. Sanitation, appropriate packaging, and refrigeration are essential practices to extend the shelf life of minimally processed products. Therefore, this study evaluated the quality of peach palm heart produced in Pariquera-Açu – SP, minimally processed in the form of chopped cut and stick, packed in different plastic packages and kept under refrigeration (10 ± 0.5 °C and 85 ± 5% RH) for 9 days. Hearts-of-palm, in chopped cut and stick, packed in PET and PP trays with lids, had their fresh masses and luminosity preserved for 9 days, but there was a failure in the sealing of the lid, which allowed gas exchange with the environment, compromising its quality. The peach palm heart cut in stick, packed in a stretchable PVC coated PE tray, provided protection and efficiency in maintaining quality. The packaging of chopped hearts-of-palm in LDPE packages (0.04 and 0.07 mm), over the storage time, resulted in a high CO_2 concentration inside the package, thus, these packages are not recommended.

Keywords: *Bactris gasipaes* Kunth, Shelf life. Packaging. Post-harvest.

Introduction

The heart-of-palm of peach palm (*Bactris gasipaes* Kunth) has a sweetish taste, slightly yellowish color, more pasty palatability, and less sensation of fibrosity compared to other types of hearts-of-palm (BERNHARDT, 1999). It also has the advantage of not presenting, after cutting, the characteristic darkening caused by oxidative enzymes that occur in extractive species (CHAIMSOHN, 2000), and this contributes to its commercialization as minimally processed.

After stem harvesting, the heart-of-palm is divided and classified into different portions. The industrialized (canned) heart-of-palm is defined as the final product consisting only of young, unexpanded palm leaves, and the presence of the apical bud and the slightly more developed outer leaf can be admitted, as long as the sheath remains imbricated. (FERREIRA et al., 1976). The portion called 'first-rate heart-of-palm' or 'cream' is marketed as stalks, which are, by definition of Agência Nacional de Vigilância Sanitária (ANVISA; Resolution RDC no17, of November 19, 1999), pieces length not exceeding 95 mm. The portion immediately below the apical bud, known as the tender stem or basal portion (stem heart-of-palm), is similar to the first-rate heart-of-palm, but with a different structure and consistency, since it is formed, botanically, by the stem (stipe) of the palm. This portion is sold, predominantly, in parts (chopped into cubes, slices of different thickness, balls, spaghetti or lasagna type). The portion called apical residue or tender leaf can still be used, which consists of the portion above the first-rate heart-of-palm which, due to the more developed leaves, has different consistency and aspect, being considered, as well as the stipe portion, second-rate heart-of-palm (RAUPP AND CHAIMSOHN, 2001; Modolo et al. 2020). Yuyama et al. (1999) report that heart-of-palm is a hypocaloric vegetable (100 g only has 26 calories), with significant levels of fiber and mineral elements such as potassium, calcium,

and magnesium, and it can be incorporated into calorie restriction diets. The consumption of heart-of-palm provides many benefits, but when consumed canned it has a high concentration of sodium, which in excess may offer health risks. Using this product *in natura* enables one to enjoy the various properties of heart-of-palm without health damage.

Minimal processing consists in sanitizing and cutting products before they reach the consumer. The stresses suffered by plant tissues, caused by the different stages of preparation of the minimally processed product, generate physiological responses, such as: increase in the evolution of ethylene and increase in respiratory activity, which accelerate product perishability (ZHUANG, HILDEBRAND, BARTH, 1997). In this sense, sanitation, use of appropriate packaging, and refrigeration are essential practices to ensure quality and extend the marketing time of minimally processed products. The primary functions of packaging are to contain, protect, and sell the product, preserving as much of its quality as possible and creating conditions that minimize chemical, biochemical, and microbiological changes that cause degradation (SARANTÓPOULOS, 2011). Meristematic tissues, such as hearts-of-palm and asparagus, have higher respiratory rates than mature tissues (KADER, 1987). Fonseca (2016) evaluated the loss of fresh mass of minimally processed peach palm heart from the median and basal regions, stored under refrigeration and packaged in plastic packaging. The author noted that, at the end of 12 days of refrigerated storage, the accumulated losses of fresh mass were 3% and 2%, respectively.

Kapp et al. (2003) observed that peach palm heart minimally processed, packaged in plastic packaging, and stored under refrigeration (10°C) presented no variation in pH values, which remained between 6.0 and 6.4 during 8 days of storage. Valentini (2010) characterized the peach palm heart-of-palm produced at different times of harvest and observed that the pH value ranged from 6.14 to 6.33, and the soluble solids from 8.3 to 6.2° Brix. Clement, Santos, and Andrade (1999) observed a shelf life of 14 days in minimally processed peach palms in the form of stick, when stored at 10°C. Fonseca et al. (2019) evaluated the physicochemical properties of peach palm heartfor minimal processing, and found 8.6° Brix mean soluble solids values and 6.5 pH for median region heart-of-palm, stick type cut, and 7.4° Brix and 6.3 pH for the basal part, chopped type cut. Kalil, Kalil Filho, and Franciscon (2010) found mean soluble solids values of 5.6° Brix and 5.7 pH.

Packaging in minimally processed products (MPPs), due to the breathing process, causes a reduction in the concentration of O_2 and elevation in CO_2, producing a modified atmosphere capable of slowing metabolism and increasing the shelf life of the product. However, very low O_2 concentrations or very high CO_2 can lead to anaerobic respiration and physiological disorders such as development of awkward taste/aroma and increased susceptibility to spoilage (WATADA; QI, 1999).

Therefore, this study evaluated the quality of peach palm heart produced in Pariquera-Açu – SP, minimally processed in the form of chopped cut and stick, packed in different plastic packages and kept under refrigeration (10 ± 0.5 ºC and 85 ± 5% RH) for 9 days.

Material and methods

The heart-of-palm was obtained from peach palm grown in the Vale do Ribeira Apta Polo, in Pariquera-Açu – SP, in the 2015. The region is characterized as Cfa (Köppen) climate, Humid Subtropical Climate, with hot/humid characteristics with temperatures below 18°C in the coldest month and above 22°C in the hottest month and average precipitation of 1,678 mm, without defined seasons (ORTOLANI et al.,

1995). Twenty-four stems of peach palm hearts were transported to the Post-harvest Laboratory of the Center for Engineering and Automation – IAC, Jundiaí-SP, where the partial removal of the outermost sheaths and the portions of the tips, which are exposed to soil contaminants during transportation, was performed.

Then, these stems were wrapped in PVC plastic film and placed in a cold room at 20°C, so as not to lose moisture, for 18 hours. After this time, the outermost sheaths were removed until the raw heart-of-palm (edible part) was obtained. The apical part of the stem was eliminated, then sanitized by immersion in an aqueous solution of 200 mg L^{-1} peracetic acid for 15 minutes, drying by draining; then the stem was separated into two portions for the stick-type cuts with approximately 9.0 cm, noble part of the heart-of-palm, and the basal parts in chopped-type cuts. Therefore, two different experiments were performed, considering the stick-type and chopped-type cut heart-of-palm.

The heart-of-palm from the basal part was sliced into 1 cm high slices and then chopped into 1 cm pieces. The sections were sanitized by immersion in an aqueous solution of 100 mg L^{-1} peracetic acid for 15 minutes, drying by draining, then they were packed in different plastic containers and stored under refrigeration (10 ± 0.5°C and 85 ± 5% RH) for 9 days, being evaluated every three days for quality.

About 300 g of minimally processed heart-of-palm were packed in different packages. The chopped type was packed in bags of low density polyethylene (LDPE) of 0.04 and 0.07 mm and sealed in trays of ethylene polyterephthalate (PET) and polypropylene (PP), with lids. The stick type was packed in PET tray with lid, polystyrene (PE) tray covered with stretchable PVC, and PP tray with lid.

The heart-of-palm was evaluated regarding the loss of accumulated fresh mass, based on the difference in initial mass of the heart-of-palm and the mass on the dates of the evaluations, by Shimadzu semi-analytical scale model BL320H, with results expressed as a percentage; concerning the content of soluble solids (SS), it was determined in drops of the centrifuged material, measured in Atago digital refractometer, with results expressed in °Brix; the pH value was determined by Digimed potentiometer, measured after direct immersion of the glass electrode in the previously centrifuged material, according to the methodology described in IAL (2008); the color was evaluated by a Hunter Lab colorimeter, MiniScan XE Plus, L*a*b* system, using L*, which represents the luminosity and indicates how dark and how light the product is (value zero for black color and value 100 for white color). The readings in each sample were taken in triplicate and the results were expressed as Luminosity index (L*) (HUNTERLAB, 2023); and for the O_2 and CO_2 concentrations inside the packages, using a PBI Dansensor CheckMate 9900 gas analyzer was used, with results in percentage. Three readings were performed for each package.

The statistical design used in the evaluation of the quality of the heart-of-palm was in blocks with repetitions, treatments (packaging), blocks (evaluation date), with three repetitions. The evaluation of chopped heart-of-palm was 4 treatments x 4 blocks, and the stick was 3 treatments x 4 blocks. The data were submitted to analysis of variance and the means were compared by Tukey's Test at 5% probability, using the Statistical Assistance Program (ASSISTAT), described by Silva and Azevedo (2009).

Results and discussion

The packages used associated with refrigeration were efficient in keeping the fresh mass of minimally processed chopped-type and stick-type hearts-of-palm during the storage period. No significant differences were found in cumulative fresh mass loss between treatments.

The chopped heart-of-palm had accumulated mass loss of 1.8%, while in the stick heart-of-palm, this loss was 1.36% at the end of 9 days of refrigerated storage. Fonseca (2016) observed a similar result at the end of 12 days of refrigerated storage. The pH and soluble solids (SS) values of chopped (Table 1) and stick hearts-of-palm (Table 2) did not vary significantly between treatments; the chopped had a mean value of pH 6.3 and SS 5.2° Brix, and for the stick, the values were pH 6.4 and SS 5.5° Brix. Kapp et al. (2003) and Kalil, Kalil Filho, and Franciscon (2010) observed a similar result for minimally processed peach palm heart.

The packages used did not influence the perception of darkening of the heart-of-palm, measured by Luminosity (L*). The closer to 100, the whiter the product, which achieved a 77.3 mean for the chopped-type and 86.5 for the stick-type. The results were statistically equal during the 9-day storage period (Table 3). The heart-of-palm did not darken regardless of the packaging used, as also mentioned by Chaimsohn (2000) and Botelho et al. (2010) for peach palm minimally processed heart-of-palm, during the refrigerated storage.

Concentrations of O_2 and CO_2 for all packages are shown in Tables 4 and 5. The metabolic reactions of the heart-of-palm, result of the breathing process, modified the atmosphere inside the packages, decreasing the concentration of O_2 and increasing CO_2 during the 9 days of storage. This was observed in the packages 0.04 and 0.07 mm LDPE bag, chopped-type, and PE tray covered with stretchable PVC, stick-type. Waghmare and Annapure (2013) and Rodrigues et al. (2006) observed similar results of decreases in O_2 and increases in CO_2 in papaya minimally processed and packaged in modified atmosphere packaging.

In the case of 0.04 and 0.07 mm LDPE bags containing chopped cut heart-of-palm, the CO_2 level was very high at the end of 9

Table 1. PH values and soluble solids (SS) of minimally processed chopped-type heart-of-palm, stored for 9 days under refrigeration (10 ± 0.5°C and 85 ± 5% RH).

	Storage period in days							
	0		3		6		9	
	pH	SS	pH	SS	pH	SS	pH	SS
LDPE bag 0.04	6.1	5.2	6.6	5.1	6.8	5.5	6.5	5.2
LDPE bag 0.07	6.1	5.5	6.6	5.8	6.0	5.3	6.6	5.9
PET tray	6.1	5.4	6.2	4.7	6.2	5.3	6.1	4.8
PP tray	6.1	5.7	6.4	5.8	6.1	4.8	6.0	4.6

Non-significant results at 5% by Tukey's test.

Table 2. PH values and soluble solids (SS) of minimally processed stick-type heart-of-palm, stored for 9 days under refrigeration (10 ± 0.5°C and 85 ± 5% RH).

Treatment	Storage period in days							
	0		3		6		9	
	pH	SS	pH	SS	pH	SS	pH	SS
PE tray	6.1	5.4	6.6	5.4	6.8	5.4	6.5	5.7
PET tray	6.1	5.6	6.6	5.8	6.0	5.6	6.6	5.2
PP tray	6.1	5.9	6.2	5.8	6.2	5.9	6.1	5.6

Non-significant results at 5% by Tukey's test.

Table 3. Luminosity (L*) of minimally processed stick-type and chopped-type hearts-of-palm, stored for 9 days under refrigeration (10 ± 0.5°C and 85 ± 5% RH).

Treatment	Storage period in days			
	0	3	6	9
	Chopped			
LDPE bag 0.04	75.18	77.30	79.31	74.82
LDPE bag 0.07	75.18	79.62	81.40	77.45
PET tray	75.18	75.05	78.65	73.24
PP tray	75.18	77.37	77.29	75.00
	Stick			
PE tray	88.69	86.89	86.39	86.41
PET tray	88.69	85.73	85.73	84.96
PP tray	88.69	88.30	88.30	84.42

Non-significant results at 5% by Tukey's test.

Table 4. Concentration of oxygen (%) and carbon dioxide (%) inside the packages containing minimally processed chopped-type heart-of-palm, stored for 9 days under refrigeration (10±0.5°C and 85±5% RH).

Treatment	Storage period in days							
	0		3		6		9	
	O_2	CO_2	O_2	CO_2	O_2	CO_2	O_2	CO_2
LDPE bag 0.04	13.4 b	3.7 A	12.9 b	7.7 A	9.3 b	11.5 A	1.4 b	22.1 A
LDPE bag 0.07	9.8 b	5.6 A	14.1 b	10.3 A	18.8 a	12.8 A	2.5 b	19.1 A
PET tray	21.5 a	0.4 B	21.7 a	0.3 B	21.6 a	0.1 B	21.3 a	0.6 B
PP tray	18.9 a	3.3 A	20.8 a	1.3 B	19.8 a	2.7 B	20.3 a	1.7 B

Means followed by the same letter, lowercase for O_2 and uppercase for CO_2 in the columns, do not have a significant difference at 5% by Tukey's test.

days of storage, 22.1 and 19.1%, respectively, which probably caused tissue damage, leading to changes in odor at the end of the storage period, as reported by Watada and Qi (1999) in storage atmospheres with high CO_2 levels. The polystyrene tray package, coated with stretchable PVC film containing stick heart-of-palm, caused a change in the atmosphere inside the package at levels favorable to the conservation of hearts-of-palm during the storage period (Table 5).

Table 5. Concentration of oxygen (%) and carbon dioxide (%) inside the packages containing minimally processed stick-type heart-of-palm, stored for 9 days under refrigeration (10±0.5°C and 85±5% RH).

Treatment	Storage period in days							
	0		3		6		9	
	O_2	CO_2	O_2	CO_2	O_2	CO_2	O_2	CO_2
PE tray	15.0 c	2.8 A	0.5 c	4.6 A	1.0 c	4.1 B	0.6 c	4.7 B
PET tray	17.7 b	2.3 A	19.3 b	4.6 A	16.8 b	6.7 A	14.0 b	7.9 A
PP tray	21.2 a	0.8 A	21.5 a	1.0 B	10.0 a	2.1 C	20.5 a	1.6 C

Means followed by the same letter, lowercase for O_2 and uppercase for CO_2 in the columns, do not have a significant difference at 5% by Tukey's test.

The PET and PP trays with lid, containing chopped or stick hearts-of-palm, did not cause any change in the atmosphere inside the package, in which the concentration of O_2 remained high and that of CO_2 low during the 9 days of storage, due to a failure in the sealing system of the covers that allowed gas exchange with the outside air. Palharini et al. (2016) observed the same result in PP trays with lids for green beans. PET and PP trays with lids are not suitable for storing minimally processed hearts-of-palm.

Conclusions

LDPE packages (0.04 and 0.07 mm) are unsuitable for packing chopped hearts-of-palm, due to the high concentration of CO_2 that settled inside the package, resulting in anaerobiosis on the 9th day of storage. The PET and PP trays did not provide a passive modified atmosphere to maintain the quality of the chopped and stick hearts-of-palm, due to the failure of the lid seal, which allowed gas exchange with the environment. The PE trays coated with stretchable PVC provided protection, being efficient in maintaining the quality of peach palm heart-of-palm cut in stick.

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