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Combination of storage followed by drying assures higher yield and quality of macauba (*Acrocomia aculeata*) pulp oil

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ABSTRACT

Macauba is a productive palm tree species in the tropical biome, and presents some advantages, as cultivation suitable for lands outside the rain forests, and lower rate of oil acidification after harvesting. The objective of this study is to evaluate the effect of storage time of macauba fruits, followed by drying, on the pulp oil content and quality. Ripe macauba fruits stored under room conditions (23 ± 1 °C) for 0, 10, 20 and 30 days were oven dried at 60 °C and 100 °C for 24 h. The control was left undried. Physical, chemical and biochemical aspects of the pulp and physicochemical properties of its oil were evaluated. It was observed that oil content increased throughout the storage time after fruits drying, and drying the fruit at 100 °C after 30 days of storage optimizes the overall pulp oil quality.

1. Introduction

Vegetable oils are basic ingredients for several industrial sectors, such as food processing, personal hygiene, cleaning, surfactants, biofuel and animal nutrition. The main source of vegetable oils is oil palm (*Elaeis guineensis*) which supplies around 40% of vegetable oil consumed in the world, followed by soybean, which makes up 27% (Shahbandeh, 2021). However, aspects related to oil palm and soybean production models raise many questions about the massive and continuous use of these sources. The market is eager to obtain vegetable oils from other sources that encompass price competitiveness in addition to sustainable and socially acceptable production systems. It is within this scenario that macauba (*Acrocomia aculeata*) is gaining an interest in Brazil. Although macauba is also a palm tree, there are fundamental differences in relation to the oil palm that add very striking sustainability characteristics. The oil palm is restricted to the biomes of the rain forest, while macauba occurs naturally in regions with less water availability, such as the cerrado and the semiarid region of Brazil (Janick & Paull, 2008; Lanes et al., 2014; Shahbandeh, 2021). In terms of oil productivity, macauba may even surpass the oil palm (Moura et al., 2010). There are still many other advantageous aspects for the macauba, such as integrated production with crops and livestock, the larger amount of residual biomass, the harvesting system facilitated by having dehiscent fruits and slower development of acidity in the pulp oil. This last feature is very important for industrial processing logistics.

The palm oil fruit processing takes place within 24 h after harvesting to prevent unwanted acidity, and initially undergoes the enzymatic inactivation step by step treatment at high pressure and temperature. This operation requires a lot of energy and time, in addition to the high cost of the equipment. In the case of the macauba fruit there is no such need. Studies have pointed out that it can be stored in ambient conditions for about 20 days without acidity exceeding the desired levels. Another characteristic that stands out in macauba is its post-harvest metabolism. There is evidence that this fruit has a climacteric behavior, with an increase in the concentration of oil in the pulp after the abscission of the fruit.

However, there are challenges in order to establish adequate post-harvest and processing conditions. Currently, the pulp oil of macauba is extracted from dried fruit. Extraction takes place using expeller presses. Natural drying takes months to occur and results in an intense decay of the quality of the oil. Thus, the present work targets to evaluate post-harvest procedures to promote the increase of the oil content in parallel to the maintenance of the oil quality. Experiments were carried out to combine an initial stage of storage of the fruit followed by drying, and the effects on the oil content and its overall quality were evaluated.

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2. Material and methods

2.1. Site description and sample preparation

Ripe macauba fruit bunches were cut from randomly selected and tagged wild macauba trees using sickle fitted on long metal rods and dropped beneath spongy surfaces on the ground from Capela farm, Acaiaca municipality, Minas Gerais State, Brazil. Harvested fruits were collected from bunches, cleaned with a piece of neat cloth and were sorted to have uniform size. Each experimental unit consisted of twenty fruits contained in a polyethylene mesh bag. Fruits were manually peeled and pulped, and the pulp was cut into pieces for further analyses. All chemicals used were of analytical grade. The manuscript adopted standard procedures used by Tilahun et al. (2020) for sample preparation and treatment set up, physical, chemical and biochemical analyses of the fruit's pulp and physicochemical analyses of the pulp oil.

2.2. Treatment set up and application

The fruits were placed on aluminum plated hard paper tray and dried in an oven (Tecnal, Model TE 394-3, Brazil) with circulation of air at 60 °C and 100 °C for 24 h after 0, 10, 20 and 30 days of storage. Fruits were dried and analyzed at Macauba Post-harvest Laboratory, Departamento de Fitotecnia, Universidade Federal de Viçosa. The dried fruits were placed in an open plastic box at a controlled temperature of 23 ± 1 ºC. The control (23 ± 1 ºC) was left undried. Samples stored for 0 days were analyzed within 24 h after drying.

2.3. Physical analyses of macauba fruit's pulp

Cut pulp pieces were half filled in metal plates to measure water activity (Aw) at an accuracy of ± 0.02 aw at 25 °C by using PAwkit water activity meter (Decagon, Inc., USA).

2.4. Chemical analyses of macauba fruit's pulp

2.4.1. Moisture content

Moisture content (MC) was determined by evaporating the water in an oven at 105 °C (IAL (Instituto Adolfo Lutz), 1985a) after 2 h. About 5 g wet pulp was heated until constant weight attained. Then, the sample was cooled in desiccators for 10 min before reweighing. The percentage moisture content in wet-weight basis was given as:

$$\text{MC}\ (\%) = \frac{(Weight\ of\ crucible\ +\ Wet\ sample) - (Weight\ of\ crucible\ +\ Dried\ sample)}{(Weight\ of\ crucible\ +\ Wet\ sample) - (Weight\ of\ crucible)} * 100.$$

2.4.2. Oil content

Oil content (OC) was determined as per the protocol 032/V (IAL, 1985b) using n-hexane as a solvent in Soxhlet apparatus (Marconi 044/8/50, Brazil). About 5 g dried (60 ºC/24 h) and grounded pulp was wrapped in a thimble made of filter paper and assembled into the extraction chamber. Hexane was heated to reflux for 8 h. The distilled hexane was collected. The round flask containing the lipid fraction was heated at 105 ºC for about 2 h and, cooled down in desiccators and weighed. The lipid content on a dry basis was calculated by using the formula:

$$\text{Lipid content}\ (\%) = \frac{\text{Lipid weight}}{\text{Dried sample weight}} * 100.$$

2.5. Biochemical analyses of macauba fruit's pulp

About 1 g pulp (for each crude enzyme analysis) was homogenized with 20 mL of 0.1 M Tris buffer at pH 8.0 (lipase) and pH 6.5 (peroxidase) using electric blender. The crude enzyme extract was filtered through a double layer of cotton gauze and centrifuged at 6000 rpm (ExcelsaTM II Centrifuge, Mod. 206 BL, Brazil) for 10 min. The collected supernatant was stored at -20 °C, and the soluble protein was determined as per Iaderoza and Baldini (1991) at 260 and 280 nm.

Lipase and peroxidase activity were measured as per the protocol of Iaderoza and Baldini (1991) and Fatibello-Filho and Vieira (2002), respectively with modifications. Lipase activity was measured with triacetin as a substrate. The free fatty acids produced were quantified by titrating against 0.05 N NaOH. One-unit activity (unit mole^{-1}) is defined as quantity of one micromole of fatty acids released per min. Specific activity (U mg^{-1}) is defined as activity of enzyme per unit of protein at 27 °C 30 min $^{-1}$.

Protein (mg/mL) = 1.55 x A280 – 0.76 x A260, A is the absorbance reading at 260 nm and 280 nm, 1.55 and 0.76 are the correction factor.

Specific activity of lipase (U mg^{-1}) = $\frac{(V_{enzyme} - V_{control})\ \text{x}\ f_c\ \text{x D}}{\text{t}} * 50$, where V enzyme is volume of enzyme, V_{control} is volume of control, f_c is the correction factor, D is dilution factor, 50 represents number of micromoles of NaOH per mL of 0.05M solution and t is the reaction time in min.

Peroxidase activity was determined by tetraguaiacol formation in the blend solution of 1 mL of 50 mM Guaiacol, 1 mL of 15 mmol L^{-1} hydrogen peroxide, 1 mL of 0.1 M Tris HCl and 0.5 mL of crude extract. The absorbance was measured at 470 nm after 1 min (Thermo scientific, Genesys 10UV Scanning). One unit activity (unit mole^{-1}) is defined as the increasing of 0.001 absorbance unit min^{-1}. Specific activity of lipase (U mg^{-1}) is calculated by using activity of the enzyme per unit of protein.

Protein (mg/mL) = 1.55 x A280 – 0.76 x A260, A is the absorbance reading at 260 and 280 nm, 1.55 and 0.76 are the correction factor.

2.6. Physicochemical analyses of macauba pulp oil

Pulp slices were dried in an oven with circulation of air (Tecnal, Model TE 394-3, Brazil) at a temperature of 65 °C for 12 h. Then, the oil was extracted by using a manually operated hydraulic press (Prensa Ribeiro 30 Ton, Brazil) and stored at -20 °C packed in amber glass vials wrapped with aluminum foil until analysis.

2.6.1. Free fatty acids

Free fatty acids (FFA in % oleic acid) content of the pulp oil was determined according to AOCS (1983). About 2 g oil samples were dissolved in a 2:1 (vv^{-1}) ether and ethanol, and titrated with a 0.1 N KOH solution in ethanol using phenolphthalein as an indicator. The FFA (% oleic acid) content was calculated using the following equation:

Free fatty acid content (% oleic acid) = $\frac{(\text{Va} - V_b)\ \text{x}\ f_c\ \text{x N x}\ 28.2}{\text{Weight of sample}} * 100$, where Va is volume of KOH solution consumed by the sample, V_b is volume of KOH solution consumed by the blank, f_c is the correction factor, N is normality of KOH solution and 28.2 is molecular weight of oleic acid.

2.6.2. Peroxide value

Peroxide value (PV) is expressed as mill equivalents of oxygen per kg of oil (meq O_2 kg^{-1}) as per AOCS (1983). Thirty mL 3:2 (VV^{-1}) acetic acid: chloroform was added to the oil sample, followed by adding 0.5 mL potassium iodide, and left to stand for 1 min. Thirty mL of water was added, and the solution was titrated with 0.01 N sodium thiosulfate ($Na_2S_4O_6$). Finally, 1% starch was added as an indicator. The amount of peroxides is calculated by the amount of sodium thiosulfate consumed as follows:

Peroxide value (meq O_2 kg^{-1}) = $\frac{(\text{Va} - V_b)\ \text{x}\ f_c\ \text{x N}}{\text{Weight of sample}} * 1000$, where Va is volume of $Na_2S_4O_6$ solution consumed by the sample, V_b is volume of

Table 1
Water activity and moisture content of the pulp from oven dried macauba fruits in storage.

Drying temp. (°C)	Pulp water activity				Pulp moisture content (%)			
	Storage periods (days)				Storage periods (days)			
	0	10	20	30	0	10	20	30
23	0.9880Aa ± 0.0020	0.9880Aa ± 0.0081	0.9700Aa ± 0.0415	0.9780Aa ± 0.0044	65.2Aa ± 5.1	47.3Ab ± 6.7	43.9Ab± 3.1	34.8Ab ±4.9
60	0.9900Aa ± 0.0037	0.9700Aab ± 0.0079	0.9820Aab ± 0.0114	0.9100Ab ± 0.0146	34.8Ba ± 1.5	41.3Aa ± 2.6	35.3Aa ± 5.2	10.9Bb ±0.8
100	0.9080Ba ± 0.0270	0.8280Bb ± 0.0169	0.7740Bb ± 0.0128	0.7760Bb ± 0.0095	15.6Ca± 1.5	10.7Ba ± 0.9	4.7Bb ± 0.6	5.0Bb ±0.2

Means in the same column and rows followed by upper and lower case letters, respectively are significantly ($P < 0.05$) different according to Tukey's test.

$Na_2S_4O_6$ solution consumed by the blank, f_c is the correction factor and N is normality of $Na_2S_4O_6$ solution.

2.6.3. Oxidative stability

Oxidative stability (OS) is the oxidation stability index (OSI expressed in h) measured by Rancimat apparatus (873 Biodiesel Rancimat®- Metrohm) using 2.5 ± 0.01 g oil. A flow of air (10 L h^{-1}) was bubbled through the oil heated at 110 °C whose conductivity increased progressively (AOCS, 1997).

2.6.4. Total carotenoids content

Total carotenoids content (TCC in mg kg^{-1}) was determined by diluting the oil samples in 10 mL petroleum ether and the readings were taken at 450 nm absorbance (Rodriguez-Amaya & Kimura, 2004).

2.7. Statistical analysis

The experiment was conducted in a completely randomized design with five replications in factorial arrangement of three by four. The three drying temperatures (control as 23 °C, 60 °C and 100 °C) and the four storage periods (0, 10, 20 and 30 days) were considered as factors. Physical, chemical and physicochemical parameters were subjected to three; whereas biochemical parameters were subjected to eight analytical replicates, respectively. Analysis of variance and honestly significant difference (Tukey's HSD) was compared at $P < 0.05$ by using R statistics software (R version 3.5.1, 2018).

3. Results and discussion

3.1. Physical analyses of macauba fruit's pulp

3.1.1. Water activity and moisture content of the pulp

Water activity (Aw) in a biological system attributes to chemical and enzymatic reactions (Maltini et al., 2003). Water activity of the pulp was significantly ($P < 0.05$) affected by drying temperature, storage periods and their interactions. It reduced from 0.99 ± 0.004 at 60 °C on day 0 to 0.7740 ± 0.013 at 100 °C drying temperature on day 20 (22% reduction) (Table 1). This could be related to the mucilaginous nature of the pulp that held the water tightly in the tissue.

Despite this small reduction of the pulp Aw, it might lead to corresponding decline in enzymatic activities (lipase and peroxidase, Table 3). This is because water activity has a paramount importance in lipid oxidation, enzymatic and non-enzymatic reactions and microbial growth (Barbosa-Cánovas et al., 2003). The pulp is tasty with attracting fragrance. The sweet taste of the pulp proved presence of reducing sugars (Montoya et al., 2016); therefore, the interaction of water with solutes (sugars) in the tissue of macauba fruit might complicate prediction of ideal water activity during storage.

Moisture content (MC) of the pulp was highly (0<0.0001) affected by the interactions of storage periods and drying temperature (Table 1). It ranged from 65.2 ± 5.1% in control on day 0 to 5.0 ± 0.2% at 100°C drying temperature (92% decrease) on day 30 (Table 1). The higher the moisture content the more time required in drying and becomes more difficult in extracting the oil. That is why; drying at high temperature was found to be efficient in reducing the moisture content as there was fast migration of water from the fruit to the environment. Removal of excessive water extends shelf life and preserves oil quality in storage. However, high moisture in macauba pulp can be a major concern as it has high cost implication during oil extraction (Ciconini et al., 2013). Thus, drying facilitates in the oil extraction, would reduce the negative impact of enzymatic activity that deteriorates the oil quality and overall shelf life.

Table 2
Oil content of macauba pulp and free fatty acids in the oil of fruits stored at room temperature followed by drying at different temperatures.

Treatment	Oil content (% dry basis)	Free fatty acids (% oleic acid)
Drying temperature (°C)		
23 (control – no drying)	47.7b ± 2.41	2.18 ± 0.26
60	51.1b ± 1.23	2.09 ± 0.24
100	59.3a ± 1.09	1.99 ± 0.39
Storage periods (days)		
0	46.1c ± 1.70	0.30b ± 0.04
10	53.6ab ± 1.03	0.75b ± 0.17
20	52.7b ± 2.73	1.37b ± 0.37
30	58.3a ± 0.84	5.92a ± 0.61

Means in the same column followed by lower case letters are significantly ($P < 0.05$) different according to Tukey's test. The interaction of storage periods and drying temperatures was not significant for both parameters.

3.2. Oil content of the pulp and oil characteristics

3.2.1. Oil content

Oil content (OC in dry basis) was highly (0<0.0001) affected by the main effects of storage periods and drying temperatures (Table 2).

Oil content changed from 46.1 ± 1.70% on day 0 to 58.3 ± 0.84% on day 30 (27% increase) along storage (Table 2). With the increase in drying temperatures, the average OC of the pulp increased from 47.7 ± 2.41% in control to 59.3 ± 1.09% in 100°C drying temperature (24% increase) as shown in Table 2. This could be associated with climacteric behavior of macauba fruit that converts stored reserves to oil and accumulate more oil as the fruits were kept at room conditions and followed by drying.

The increasing oil contents observed after drying could be due to the boost in the conversion of carbohydrates to lipids, while the tissues of the pulp were still physiologically actives, before the metabolism collapse with the constraining temperature. Oil content is a crucial parameter to the whole production of any oil bearing species. Therefore, such increment in the post-harvest is a valuable characteristic of the macauba fruit and an advantage over oil palm.

3.2.2. Free fatty acids

Free fatty acids (FFA) was highly (0<0.0001) affected by the main effects of storage periods, but neither by the drying temperatures nor by the interaction of the main effects (Table 2). Even fruits stored up to 20 days showed in average free fatty acids percentage of below 2%. The

drying procedure did not affect the release of fatty acids. It is worthy again a comparison to palm oil that has to be extracted up to 24 h after harvesting in order to achieve the acceptable free fatty acids content. Free fatty acids were increased from 0.30 ± 0.04% in fresh fruits to 5.92 ± 0.61% at 100°C dried fruits in the 30th storage day (Table 2). In this study, FFA was below the crude palm oil standard limit of 5% at maximum as per Brazilian Health Surveillance Agency (ANVISA, 2005; PORIM, 2011) as well as below the industrial and economical acceptable range of 3% (Nunes et al., 2015), under drying at 60 °C until the 20th day.

The increase in FFA after 20 day might be associated with autocatalytic hydrolysis and/or other interlinked factors. Studies affirmed that autocatalysis of free fatty acids was reported in stored palm oil with moisture content greater than 0.13–0.15% and water activity greater than 0.5 (Yuen et al., 2006). These preconditions could be satisfied in this study. Acidity as an important oil quality trait, optimizing the proper drying temperature and storage duration fulfills the acceptable free fatty acid standards of the industries and economic benefit of macauba production.

3.2.3. Peroxide value

Irrespective of the increased peroxides value (PV) in the first 10 days at 100°C drying temperature (Table 3), it was below the maximum crude oil limit of 10 meq O_2 kg^{-1}oil as per Brazilian Health Surveillance Agency (ANVISA, 2005). Peroxides value is highly ($P < 0.001$) significant to the interaction of storage time and drying temperatures (Table 3). The average PV ranged from 2.15 ± 0.11 meq O_2/kg in fresh fruit to 6.21 ± 0.43 meq O_2/kg oil at 100°C dried fruit on day 20 (Table 4). Peroxide value measures formation of hydro peroxide as a primary oxidation product in double bonds of unsaturated fatty acids. This would lead to subsequent breakage of unsaturated fatty acids. Predominance of monounsaturated fatty acids (oleic) led to peroxides formation (Nunes et al., 2015) in macauba. However, synthesis of carotene offers better oxidative stability of the oil and thus absorbs the release of volatile compounds during drying at high temperature.

3.2.4. Oxidative stability

Lower peroxide value indirectly indicates better oxidative stability (OS) of the oil. Oxidative stability is resistance of oils to oxidation in exposure to high temperature. The main effects of storage, drying temperature and their interaction was highly ($P < 0.001$) significant on OS (Table 3). The OS ranged from 5.3 ± 1.11 h to 16.7 ± 0.99 h in fresh fruit on day 10 and 16.7 ± 0.47 h at 100°C dried fruit on day 20. The result of this study was greater than 4.87 h (Coimbra and Jorge, 2011), but less than 25 h (Melo et al., 2014) in undried fresh macauba pulp oil. Oxidative stability in the control treatment (undried/fresh fruit) was equivalent to the dried fruit. This could be related to reduction in the formation of peroxides and an increase in the synthesis of carotene content.

3.2.5. Total carotene content

Lower peroxide value and better oxidative stability values are associated with high carotene content to protect the oil against degradation. This affirms that macauba pulp oil has good resistance to oxidation in response to high temperature exposure. Total carotene content was highly ($P < 0.001$) affected by storage periods, drying temperature and their interaction (Table 4). Total carotene content (TCC) was in the range of 65.5 ± 0.60 mg kg^{-1} in fresh fruits to 105.2 ± 3.25 mg kg^{-1} (61% increases) in 100°C dried fruits at the 30th day (Table 3). Presence of sugars resulted in caramelization process during drying. This process masked proper quantification of TCC. Nevertheless, drying could not inhibit synthesis of carotenes that assures resistance of the oil to oxidation during storage and processing in macauba oil.

Table 3
Peroxide value, oxidative stability, total carotene content of the pulp oil from oven dried macauba fruits after storage.

Drying temp. (°C)	Peroxide value (meq O_2kg^{-1} oil)				Oxidative stability (hour)				Total carotene content (mgkg^{-1})			
	Storage periods (days)				Storage periods (days)				Storage periods (days)			
	0	10	20	30	0	10	20	30	0	10	20	30
23	2.15Ab ± 0.11	11.7Aa ± 0.08	10.3Ba ± 0.86	11.7Aa ± 0.08	11.7Ab ± 0.08	10.3Bb ± 0.86	16.7Aa ± 0.99	5.3Bc ± 1.11	65.5Ab ± 0.60	83.2Aa ± 0.78	82.6Ba ± 2.35	74.8Bab ± 3.35
60	2.15Ac ± 0.12	9.9Ab ± 0.17	13.5ABa ± 0.36	9.9Ab ± 0.17	9.9Ab ± 0.17	13.5ABa ± 0.36	11.6Bb ± 1.18	10.5Ab ± 1.81	57.8Ab ± 1.48	72.4Ba ± 2.60	71.3Ca ± 0.86	70.8Ba ± 2.59
100	2.14Ab ± 0.11	11.8Aa ± 1.19	16.7Aa ± 0.47	11.8Aa ± 1.19	11.8Ab ± 1.19	16.7Aa ± 0.47	14.8ABa± 1.66	13.7Aa ± 1.05	60.0Ac ± 1.17	72.8Bb ± 0.75	101.9Aa ± 2.85	105.2Aa ± 3.25

Means in the same column and rows followed by upper and lower case letters, respectively are significantly ($P < 0.05$) different according to Tukey's test

Table 4
Specific activity of lipase (SAL, Umg^{-1}) and peroxidase (SAP, Umg^{-1}) of oven dried macauba fruits in storage.

Drying temp. (°C)	Specific activity of lipase (U/mg)				Specific activity of peroxidase (U/mg)			
	Storage periods (days)				Storage periods (days)			
	0	10	20	30	0	10	20	30
23	22.9Aa ± 2.8	8.1Ab ± 1.5	7.3ABb ± 1.3	4.6Ab ± 0.9	5582Ba ± 578	5980Aa ± 256	7458Aa ± 531	6408Aa ± 542
60	20.8Aa ± 1.4	8.8Abc ± 0.9	12.2Ab ± 1.5	4.6Ac ± 0.3	9064Aa ± 288	6648Ab ± 467	7291Aab ± 790	6472Ab ± 710
100	6.5Ba ± 1.7	4.5Aa ± 0.5	3.9Ba ± 0.3	3.9Aa ± 0.7	75Ca ± 20	10Bb ± 4.3	11Bb ± 4.1	5.6Bc ± 1.5

Means in the same column and rows followed by upper and lower case letters, respectively are significantly ($P < 0.05$) different according to Tukey's test

3.3. Biochemical analyses of macauba fruit's pulp

3.3.1. Specific activity of lipase (SAL) and peroxidase (SAP)

Both the specific activity of lipase (SAL) and peroxidase (SAP) were significantly ($P < 0.05$) affected by the interactions of drying temperatures and storage periods (Table 4).

Peroxidase activity did not change along the storage in the fruits with no drying (Table 4). On the other hand, lipase seems to be less stable, and its activity was deeply reduced considering in the length of storage (Table 4). Regarding the water availability, the specific activities of lipase and peroxidase followed the same pattern of the water activity, being reduced from the fresh fruits to the more intense drying at 100 °C (Table 4). It was decreased from 22.9 ± 2.8 U mg^{-1} in control on day 0 to 3.9 ± 0.7 U mg^{-1} at 100°C drying temperature on day 30 in specific activity of lipase (83% reduction); and 9064 ± 288 U mg^{-1} in control at day 0 to 5.6 ± 1.5 U mg^{-1} in 100 °C drying temperature in specific activity of peroxidase (100% reduction) at the 30th day. Lipase activity in oil palm was also constrained by lower water content during drying (Tan et al., 2009).

Peroxidase was reported as one of the most heat stable enzymes in fruit and vegetables that causes quality deterioration in storage (Burnette, 1977). Our findings to macauba pulp showed that both peroxidase and lipase did not lose activity after drying at 60°C irrespectively to the storage period. However, lipase and peroxidase activity were decreased to a great extent when the drying temperature was increased to 100 °C; nevertheless, they were not completely inactivated (Table 4).

4. Conclusions

In this study, storage periods, drying temperature and their interaction exerted an influence on physical, chemical and biochemical activities of the fruit, and physicochemical properties of stored macauba fruit's oil. Moisture content of the pulp was reduced to desirable pattern at 100 °C, and consequently led to a remarkable reduction of pulp's water activity. Oil content was increased after storage periods with increasing drying temperature possible due to its climacteric behavior. Free fatty acids release in macauba pulp oil occurred in a low speed and the oil kept a suitable level up to 20 days of storage, and the drying process did not affect this index. Oxidative stability was greatly benefited by drying fruits immediately after harvest, mostly at 100°C. Carotenoids were synthesized in the first 10 days of storage; however, there is an increasing trend after drying at 100 °C could be a misleading detection from the caramelization process. Drastic reduction of water activity was related to a corresponding decline in the specific activity of decaying enzymes of lipase and peroxidase at 100 °C drying temperature. With regard to oxidation parameters, drying fresh fruits does not lead to an increase in peroxide index beyond the stated limit across all treatments. Therefore, drying macauba after some period of storage of the fruits is a worth post-harvest practice because it assured the highest oil content with acceptable quality. These findings contribute to the settlement of an advantageous and strategic chain value for macauba.

Declaration of Competing Interest

The authors declare that they have no competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

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