



Water and Pulp Quality of Green Coconut Produced with Mulching and Irrigation Frequency

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Authors' contributions

This work was carried out in collaboration between all authors. Author KGS elaborated the study, participated in all the steps of conducting and wrote the manuscript. Author FBC consisted of the research supervisor, showed the alternatives of conducting and evaluated the data, assisted in the statistical part of the work. Authors YLB and ÁGFS participated in the process of planning and conducted the experiment, besides participated in the writing of results and discussions. Authors GOP and VMM were responsible for the part of the methodology of the manuscript, review of the bibliography. Authors AMN and JLS were the paramount importance in the conduction and evaluation of the experiment, data typing process for later statistical analysis. Authors MSS, AXMQ and GNBS were decisive in the correction phase, showing alternatives to enrich the information work, introductory part of the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2018/44284

Editor(s):

(1) Dr. Wafaa Haggag, Professor, Plant Pathology Department, Agriculture and Biology Research Division, Egypt.

Reviewers:

(1) Prahlad Deb, Institute of Agriculture, India.

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(3) Miguel Aguilar Cortes, Universidad Autonoma del Estado de Morelos, Mexico.

Complete Peer review History: <http://www.sciencedomain.org/review-history/26438>

Original Research Article

Received 01 July 2018

Accepted 22 September 2018

Published 28 September 2018

ABSTRACT

Objective: The objective was to evaluate the postharvest quality of the water and the green coconut pulp.

Experimental Design: The experiment was conducted in a random block design, corresponding to the use of treatments with and without mulching, combined with five irrigation frequencies.

Place and Duration of the Study: The experiment was held at the Várzeas de Sousa project, located between the municipalities of Sousa and Aparecida, in the hinterlands mesoregion of Paraíba state, where it was taken to the Agrifood Science and Technology Center of the Federal University of Campina Grande, Pombal campus, in October 11, 2017.

Methodology: The testing was conducted in random blocks, in a 2 x 5 factorial scheme, (factor 1: treatments with and without mulch and factor 2: irrigation frequency (TR1: daily irrigation; TR2: irrigation every 2 days; TR3: irrigation every 3 days; TR4: irrigation every 4 days; and TR5: irrigation every 5 days).

Results: Treatments didn't influence the physical-chemical characteristics of green coconut water or pulp, being the variables within the current standards and norms.

Conclusion: Use of mulch enabled the coconut to obtain higher ratio values SS/TA, regardless of irrigation interval, very important from a commercial point of view and acceptance of water. In the pulp, greater prominence was observed for the phenolic compounds of the fruits treated with the use of mulch and independent of the irrigation shift.

Keywords: Green coconut; physical-chemical characteristics; irrigation.

1. INTRODUCTION

The coconut tree (*Cocos nucifera* L.) belongs to the Palmae family, to the cocos genus and is one of the most important families in the Monocotyledoneae class [1], has originated from southeastern Asia and widespread throughout the planet, being its fruits sold processed or unprocessed [2].

Brazil is the fourth coconut producer in the world and the biggest producer in South America, with a cultivated area of roughly 280.000 hectares, evenly distributed nationwide, producing around two billion fruits [3], the most favorable conditions to its cultivation are presented in the Northeast region, which concentrates most of the production, with 220.339 cultivated hectares [4], where the demand for green fruits for ready consumption has increased significantly [5].

The coconut palms most used commercially are the *Typical* (giant coconut palm) e a *Nana* (dwarf coconut palm), this variety is composed of the green, yellow and red plants [6]. O dwarf coconut palm starts bearing fruit between 2 and 3 years after being planted, having a slow vegetative development, producing an average of 150 to 200 fruits a year, and its main usage is coconut water producing since it has more pleasant sensory characteristics [1].

Coconut water (liquid albumen) is a natural drink that corresponds to roughly 25% of the fruit's weight, it is present in the seed cavity and is a

light, fresh and low-calorie drink that is similar to the isotonic drinks used by sports practitioners to hydrate and restore mineral salts [7].

Other than the coconut water, the dwarf variety has the pulp (solid albumen) that is used economically in Brazil as the raw material to the manufacture of shredded coconut, coconut milk and to dry coconut marketing [8], however, the agribusiness prefers the hybrid coconut solid albumen [9].

Although the fact that the dwarf coconut is a prominent cultivation in the northeast region, its cultivation goes through dire problems, since it is a plant that needs plenty of water to keep its production, and northeastern Brazil is facing a major water crisis, thus making the efficient irrigation usage [10]. The soil hydric deficit, caused by uneven distribution of rainfall throughout the year is one of the main factors that contribute to the low productivity of the palm in the different regions where it is cultivated [11]. The unevenness of rainfall in the northeastern semiarid makes the implementation of agricultural systems hard, this fact being a problem in the development of plants seen as important to this region [12]. An important factor to the dwarf coconut management is knowing the most adequate irrigation frequency, since when properly watered the palm tree has high yield [13].

Another option to agriculture and yield improvement of the dwarf green coconut is the

usage of mulch, that helps diminishing water loss due to evaporation [14].

The farming practices can interfere in the final characteristics of the dwarf green coconut water. That said, it is essential to know techniques that can help in yield increase and quality of the final product. This way, it was aimed to assess the physical-chemical characteristics of the coconut water and pulp with and without mulching, combined with irrigation systems with determined irrigation frequencies.

2. MATERIALS AND METHODS

The present paper was developed through the Várzeas de Sousa Irrigation Project, that is located on lands in the municipalities of Sousa and Aparecida, in the hinterlands mesoregion of the state of Paraíba, inserted in the Peixe and Piranhas river basins, accessed through BR-230 highway, 440 km away from the capital city, João Pessoa.

2.1 Plant Material

The green dwarf coconut palm experimental area was planted 7 years ago, with 7 m between lines and 7 m between plants, totaling 50 fruits, that were divided in 5 blocks of 10 coconuts each, being 5 coconuts with mulching and 5 without both with five irrigation frequencies (TR1: daily irrigation; TR2: irrigation every 2 days; TR3: irrigation every 3 days; TR4: irrigation every 4 days; and TR5: irrigation every 5 days, totaling 25 coconuts with mulch and 25 without). Treatments with irrigation frequencies started on

November 25, 2016, and the adoption of mulching started on January 25, 2017, totaling 256 days of mulching. Coconuts used in this study had from 6 to 7 months of age after their flowering.

To the area where mulching was used, 6 wheelbarrows of milled coconut leaves were spread, utilizing a diameter that was 10 cm thick, interleaving plants with mulch and plants without. Water used to irrigate came from tubular wells and Amazonas wells being the experiment irrigated through pumped tubes, with systems localized by micro-sprinklers emitted by plants, with a flow of 120 liters.

Harvest and transport of the raw material were done on October 11, 2017, when the fruits were conditioned and identified by treatments in nylon bags (60 kg), sorted by irrigation frequency utilized and treatments with and without mulch. After that, they were taken to the Chemistry, Biochemistry, and Food Analysis Laboratory of the Agrifood Science and Technology Center – CCTA, of the Federal University of Campina Grande – UFCG, Pombal campus, where on October 12, 2017, the physical-chemical analysis took place.

2.2 Processing of Green Coconuts

Coconuts were received in the laboratory (Fig. 1A), selected and sorted by treatment (Fig. 1B), to obtain the water a stainless steel coconut opener was used (Fig. 1C), after that the water (liquid albumen was extracted, and filtered through a plastic sieve (Fig. 1D).

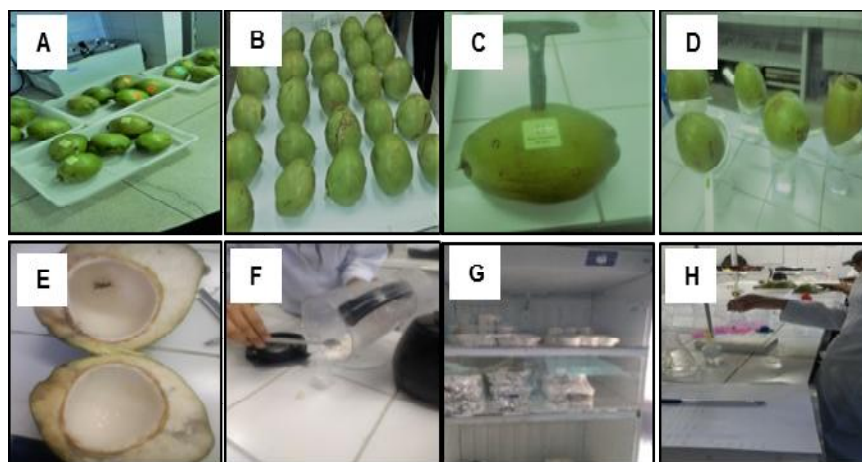


Fig. 1. Fluxogram of the processing of water and pulp of the coconut from the dwarf green coconut palm produced in the high hinterlands of Paraíba, with and without mulch, under different irrigation frequencies
(CC = with mulch; SC = without mulch)

Coconuts were opened to remove the pulp with a stainless steel machete, cutting the coconut lengthwise in half, when the pulp (solid albumen) was removed and later blended in an Arno brand blender, in order to obtain the extract (Fig. 1F), after processing the samples were kept under refrigeration in plastic containers covered with aluminum foil (Fig. 1G), after that they were submitted to analysis (Fig. 1H).

2.3 Physical-Chemical Assessment

- Hydrogenionic potential (pH): was determined directly in the recipient containing dwarf green coconut water and pulp, utilizing a bench digital potentiometer (Digimed brand), following the recommendations of Instituto Adolfo Lutz [15].
- Titratable acidity: 5 mL of coconut water and 2 grams of the pulp were transferred to an Erlenmeyer flask completing to 50 mL of distilled water and 2 drops of phenolphthalein, and later it was titrated against Sodium Hydroxide at 0.1 M. The results were expressed in percentages of malic acid, following the recommendations of Instituto Adolfo Lutz [15].
- Soluble solids: water was directly determined in the refractometer, and the pulp was macerated, filtered through cotton and read directly in the digital refractometer with automatic temperature compensation, of the model ITREFD65, being the result expressed in percentage of soluble solids [15].
- Soluble solids/titratable acidity ratio: was obtained dividing the values of soluble solids by the values of titratable acidity.
- Ascorbic acid: was estimated through titration, utilizing 5 mL of coconut water and 2 grams of pulp, completing the volume to 50 mL with 0.5% oxalic acid and titrated against Tillmans solution until colored pink, according to the method of Instituto Adolfo Lutz [15].
- Phenolic compounds: were estimated through the Folin-Ciocalteu as described by Waterhouse [16]. The extracts were prepared with 1 mL of coconut water and 1 g of coconut pulp, both diluted in 50 mL of distilled water and left to rest for 30 minutes. An aliquot of 800 μ L of the extract was transferred to a test tube containing 1.325 μ L water and 125 μ L Folin-Ciocalteu reagent. The mixture was left to rest for 5 minutes and later 250 μ L sodium carbonate at 20% was added, followed by agitation and resting in a water bath at 40°C, for 30 minutes. Readings were done in a spectrophotometer of the Spectrum brand,

model 1105. The standard curve was prepared with Gallic and readings measured at 765 nm.

2.4 Statistical Analysis

A 2x5 factorial scheme was used, (factor 1: treatments with and without mulch and factor 2: irrigation frequency (TR1: daily irrigation; TR2: irrigation every 2 days; TR3: irrigation every 3 days; TR4: irrigation every 4 days; and TR5: irrigation every 5 days). The experimental design used was the randomized block design (RBD), the results of the physical-chemical readings were statistically obtained during variance analysis (ANOVA) and Tukey test was applied, at 5% of probability, through the Assistant software (version 7.7) [17].

3. RESULTS AND DISCUSSION

3.1 Quality Parameters of Green Coconut Water

On Chart 1 are the results obtained for the assessed physical-chemical parameters in green coconut. It was found that either using mulch or not using it, combined with five determined irrigation frequencies (TR1: Daily irrigation; TR2: Irrigation every 2 days; TR3: Irrigation every 3 days; TR4: Irrigation every 4 days; and TR5: irrigation every 5 days), did not interfere in the physical-chemical characteristics of the dwarf green coconut water.

On Chart 1 there are the values of pH, titratable acidity, soluble solids, SS/AT ratio, ascorbic acid and phenolic compounds in green coconut water. There was no significant difference on the pH of the green coconut water with and without mulch under different irrigation frequencies, where the treatment with mulch resulted in a pH between 4.8 to 5.2, and the treatment without mulch the pH ranged from 4.6 to 5.0, being the results inside the standards established by the normative n° 39, from July 22, 2009 [18], which establishes a minimum pH of 4.3 for coconut water. Camboim Neto [19], when studying the influence of different irrigation plates and percentages of wet area in dwarf green coconut palm, found pH ranging from 4.6 to 4.9 increasing as fruits got older, as they were 6, 7, 8 and 9 months, being the results close to the referent research. Assessing coconut water sold by vendors in the municipality of Mossoró-RN, Vasconcelos et al. [20] found pH between 4.8 and 5.9 is close to this studies. According to Nery et al. [21], the hydrogenic potential is important to

the sweet taste and appetizing astringency that is achieved in a pH of 5.5. Elevated values in pH can indicate the development of microorganisms, however, the legislation doesn't establish maximum values for this kind of food.

Titrateable acidity (Chart 1), there was a significant difference ($p \geq 0.05$) in the treatment with mulch, where the irrigation frequencies IF3 and IF5 were slightly superior to the others, the means of the irrigation frequencies varied from 0.09 to 0.10% malic acid. There wasn't a significant difference ($p \geq 0.05$) in relation to the contents of titrateable acidity in the five irrigation frequencies without mulch (Chart 1), where contents ranged from 0.11 to 0.13%. According to Sahari [22] enzyme reactions, the presence of microorganisms, storage time are alterations that can be associated with alterations in the acidity content. The present research showed an average content of 0.09 to 0.13% of malic acid, inside the standards established by the normative n° 39, from May 29, 2002, with a minimum of 0.03% and a maximum of 0.18% [23]. According to Bobbio [24] acidity is an important factor, since it is used as a sensory indicator. Silva et al. [25] when studying physical-chemical characteristics of dwarf green coconut water found an average of 0.025% of malic acid in the liquid album of coconuts cultivated in the municipality of Assu-RN. In Imaizumi's work [26] A value of 0.06% in liquid albumen of dwarf green coconut was found, both in natural and processed.

There were no significant difference ($p \geq 0.05$) insoluble solids (Chart 1) in coconut water from

different irrigation frequencies and mulching, where for the treatment with mulch the contents of soluble solids ranged from 6.5 to 6.7% and the ones without mulch varied from 6.3 to 6.7%. Aroucha et al. [27] when studying the quality of dwarf green coconuts with seven and eight months found an average of 5.3 to 5.4% of soluble solid content, respectively, results lower than the ones found in this paper. Silva et al. [28] when studying the physical-chemical characteristics of dwarf green coconut water produced in different systems of production found values similar to the ones on this study to an organic system, that was in average 6.0%. However, Silva [29] assessing plants of dwarf green coconut pam found to the green Jiqui plant and the yellow Gramame plant 7.3 to 7.4% respectively, between 189 and 181 days.

According to Tavares et al. [30], soluble solids is one of the most used post-harvest parameters in defining the quality of the coconut liquid albumin, being around 6.0% in coconut water. Being a sugar sweetness indicator, giving taste to coconut water [31], enabling its use as a reference to the harvest point [32], since over-ripening the soluble solids increase. The consuming market has not of yet established a minimum limit for soluble solids for accepting coconut water. Some authors bring 5.0 and 6.0% Jackson et al. [32]; 6.0 and 7.0% Araújo [33]; 5.2 and 9.2% Aragão et al. [34]; 7.37 and 7.58% Isepon et al. [35], as being ideal by the occasion of dwarf coconut palm harvest, being the present research inside this value range from the other authors.

Chart 1. Hydrogenionic potential (pH), titrateable acidity (AT), soluble solids (SS), the soluble solids/titrateable acidity ratio (SS/AT), ascorbic acid (AA) and phenolic compounds (CF) in green coconut water with and without mulch under different irrigation frequencies

Variables	Mulching	TR 1	TR 2	TR 3	TR 4	TR 5	CV (%)
pH	With	5.18±1.0 ^{aA}	4.9± 0.3 ^{aA}	5.0±0.7 ^{aA}	4.8±0.4 ^{aA}	5.2±0.5 ^{aA}	4,5
	Without	4.9±0.6 ^{aA}	4.6±0.4 ^{aA}	5.0±0.3 ^{aA}	4.6±0.1 ^{aA}	4.9±0.4 ^{aA}	
AT (%)	With	0.09±0.01 ^{bA}	0.09±0.02 ^{bA}	0.10±0.01 ^{aA}	0.09±0.01 ^{bA}	0.10±0.01 ^{aA}	13,9
	Without	0.12±0.01 ^{aA}	0.13±0.02 ^{aA}	0.11±0.01 ^{aA}	0.12±0.01 ^{aA}	0.11±0.03 ^{aA}	
SS (%)	With	6.7±0.21 ^{aA}	6.6±0.2 ^{aA}	6.5±0.41 ^{aA}	6.5±0.25 ^{aA}	6.5±0.35 ^{aA}	4,5
	Without	6.7±0.37 ^{aA}	6.6±0.31 ^{aA}	6.6±0.22 ^{aA}	6.5±0.23 ^{aA}	6.3±0.37 ^{aA}	
SS/AT	With	147.2±11.1 ^{bA}	148.0±18.0 ^{bA}	129.6±14.0 ^{aA}	139.4±4.9 ^{bA}	129.7±9.6 ^{aA}	16,7
	Without	120.6±6.9 ^{aA}	94.6±6.9 ^{aA}	109.8±6.7 ^{aA}	105.0±4.0 ^{aA}	115.2±14.2 ^{aA}	
AA (mg/100 g)	With	2.0±0.3 ^{aA}	2.1±0.4 ^{aA}	1.8±0.3 ^{aA}	2.2±0.5 ^{aA}	2.3±0.6 ^{aA}	20,6
	Without	1.7±0.2 ^{aB}	2.6±0.6 ^{aA}	2.2±0.5 ^{aAB}	2.4±0.6 ^{aAB}	2.2±0.6 ^{aAB}	
CF (mg/100 g)	With	13.4±1.5 ^{aA}	16.2±6.6 ^{aAB}	14.3±3.4 ^{aA}	11.0±3.0 ^{aA}	9.0±3.0 ^{aA}	28,8
	Without	14.3±3.3 ^{aA}	13.4±2.3 ^{aA}	15.6±4.1 ^{aA}	13.4±2.0 ^{aAB}	10.2±5.4 ^{aA}	

Means followed by the same lower case letter in the column don't differ, on Tukey test ($P>0.05$). Means followed by the same capital letter in the lines don't differ, on Tukey test ($P>0.05$). CV: variance coefficient

As for the SS/AT ratio, there was a significant difference ($p \geq 0.05$) significant (Chart 1) to treatment with mulch, in which the irrigation frequencies TR1, TR2 and TR4 differed from the other irrigation frequencies with higher means, the results for mulch ranged from 129.6 to 148.0. As for the treatment without mulch didn't differ statistically among itself, being the results between 94.6 and 120.6. The SS/AT ratio is of crucial importance to evaluate the ripening of the fruits and consequently their taste, indicating the sweetness degree of a certain fruit [36]. According to Chitarra e Chitarra [31], SS/AT ratio is one of the most utilized forms to evaluate taste, being more representative than the isolate sugar measurement or acidity measurement. This relation gives a good idea of the balance between these two components. Green coconut water had a good characteristic in the SS/AT ratio, having more soluble solid content and less acidity, therefore tasting better. Silva et al. [25] studying the physical and physical-chemical characteristics of dwarf green coconut water found an average of 244.6 for ambient 1 and 372 for ambient 2, being superior to the ratio of the following research.

There was no significant difference ($p \geq 0.05$) (Chart 1) for the ascorbic acid content in the 5 irrigation frequencies with and without mulch, where the values with mulch were 1,8 to 2,3 mg/100 mL and without mulch 1.7 to 2.6 mg/100 mL. Aroucha [37] and Vianna et al. [38] found in dwarf coconut water values of vitamin C ranging from 0.95 mg/100 mL in the fourth month to 3.15 mg/100 mL in the twelfth month. However, the sixth month is the richest in vitamin C. Lima [39] when assessing coconut water from the dwarf

green coconut palm commercialized by the industries of Ceará and Paraíba hinterlands found lower values to the ascorbic acid content, in average 1.6 to 1.3 mg 10 mL⁻¹. Pinheiro et al. [40] assessing coconut water from different brands through the aseptic process, found values inferior to this work, on average 0.17 to 0.23 mg/100 mL. Rosa and Abreu [41] found in average 1.2 mg/ 100 mL, being inferior to the ones found in this research.

The phenolic compounds contents didn't differ significantly ($p \geq 0.05$) with and without mulch in the five irrigation frequencies (Chart 1), wherewith mulch in the five irrigation frequencies the phenolic content ranged from 9.0 to 16.2 mg/100 g, and the contents of the treatment without mulch in the five irrigation frequencies ranged from 10.2 to 1.6 mg/100 g. The phenolic compounds are essential substances to the plant's growth and reproduction, being compounds formed under stress, infections, injuries, UV radiation [42]. In food, they have an important role in color and astringency [43].

3.2 Quality Parameters of Coconut Pulp

On Chart 2 there are the results obtained from the physical-chemical parameters assessed in the dwarf green coconut. It was noted that using mulch or not using it, combined with five determined irrigation frequencies (TR1: Daily irrigation; TR2: Irrigation every 2 days; TR3: Irrigation every 3 days; TR4: Irrigation every 4 days; and TR5: Irrigation every 5 days), did not interfere in the physical-chemical characteristics of the dwarf green coconut pulp.

Chart 2. Hydrogenionic potential (pH), titratable acidity (AT), soluble solids (SS), the soluble solids/titratable acidity ratio (SS/AT), ascorbic acid (AA) and phenolic compounds (CF) in green coconut pulp with and without mulch under different irrigation frequencies

Variables	Mulch	TR 1	TR 2	TR 3	TR 4	TR 5	CV (%)
pH	With	6.3±0.35 ^{aA}	6.3±0.13 ^{aA}	6.4±0.34 ^{aA}	6.1±0.14 ^{aA}	6.1±0.12 ^{aA}	3,92
	Without	6.1±0.28 ^{aA}	6.3±0.17 ^{aA}	6.3±0.26 ^{aA}	6.3±0.21 ^{aA}	6.4±0.30 ^{aA}	
AT (%)	With	0.10±0.01 ^{aA}	0.11±0.04 ^{aA}	0.08±0.02 ^{aA}	0.10±0.03 ^{aA}	0.10±0.03 ^{aA}	33,98
	Without	0.10±0.05 ^{aA}	0.08±0.02 ^{aA}	0.08±0.02 ^{aA}	0.10±0.03 ^{aA}	0.10±0.03 ^{aA}	
SS (%)	With	3.9±1.35 ^{aA}	4.0±0.98 ^{aA}	4.3 ±0.54 ^{aA}	3.8±1.05 ^{aA}	3.6±0.61 ^{aA}	20,18
	Without	4.4±0.38 ^{aA}	3.2±1.04 ^{aA}	4.3±0.38 ^{aA}	4.4±0.26 ^{aA}	4.0±0.68 ^{aA}	
SS/AT	With	66.8±9.4 ^{aA}	100.8±12.3 ^{aA}	95.0±12.3 ^{aA}	105.9±16.6 ^{aA}	75.8±10.3 ^{aA}	31,2
	Without	125.8±10.3 ^{aA}	65.2±9.9 ^{aA}	101.4±9.7 ^{aA}	118.3±15.8 ^{aA}	91.4±15.4 ^{aA}	
AA (mg/100 g)	With	6.4±0.8 ^{aAB}	7.4±1.7 ^{aA}	5.8±1.6 ^{aABC}	4.3±0.4 ^{aC}	4.8±0.6 ^{aBC}	20,88
	Without	5.2±0.7 ^{aA}	4.3±0.9 ^{bA}	5.4±1.2 ^{aA}	4.9±0.9 ^{aA}	4.4±1.4 ^{aA}	
CF (mg/100 g)	With	55.0±15.5 ^{aA}	48.5±7.8 ^{aA}	40.2±11.7 ^{aA}	44.7±12.2 ^{aA}	39.7±6.0 ^{aA}	22,4
	Without	37.8±7.10 ^{aA}	41.4±9.8 ^{aA}	28.5±7.7 ^{bA}	39.2±8.1 ^{aA}	31.3±3.6 ^{aA}	

Means followed by the same lower case letter in the column don't differ, on Tukey test ($P>0.05$). Means followed by the same capital letter in the lines don't differ, on Tukey test ($P>0.05$). CV: variance coefficient

On Chart 1 there are the values of pH, titratable acidity, soluble solids, SS/AT ratio, ascorbic acid and phenolic compounds in green coconut pulp.

There was no significant difference ($p \geq 0.05$) in pH of solid albumen of dwarf green coconut in the treatments with and without mulch in the five irrigation frequencies (Chart 2). It was observed that both for the treatment with mulch and the treatment without the pH values ranged from 6.1 to 6.4, respectively. Teixeira et al. [44] when studying the utilization of green coconut's albumen in the making of smoothies, found the pH of 6.53, value similar to the pH found in the present study. Soares et al. [45] also found similar values when studying the physical-chemical characteristics of green coconut pulp, found an average of 6.4 to fast freezing and 6.0 to fast freezing. The hydrogenic potential is a very important parameter for food, through its determination the growth of microorganisms can be observed, and also the enzyme activity, taste and odor retention, and also helping in the ripening assessment [46].

Titratable acidity didn't differ statistically (Chart 2). It was observed that the contents of malic acid in the treatment with mulch in the five irrigation frequencies ranged from 0.08 to 0.11%, and the values for malic acid without mulch ranged from 0.08 to 0.10%, showing stability. Teixeira et al. [44] when studying the utilization of green coconut albumen in the making of smoothies found an average acidity content of 0.06%, is this value inferior to the present research. Soares et al. [45] when studying physical-chemical characteristics of frozen dwarf green coconuts submitted to slow and fast freezing, found values similar to the ones in the present research, in average the acidity content was 0.07% in slow freezing that increased according to storage days, however, in fast freezing it was found an average of 0.12% that decreased according to storage days. Quantifying acidity in food is a very important parameter since it is through this characteristic that important data is obtained about food conservation since the organic acids present in food influence quality [46].

There was no significant difference ($p \geq 0.05$) in the soluble solids content (Chart 2), ranging from 3.6 to 4.3% to treatments with mulch in the five irrigation frequencies and 3.1 a 4.4% in the treatment without mulch in the five irrigation frequencies. Soares et al. [45] when studying the

physical-chemical characteristics of dwarf green coconut pulp submitted to slow and fast freezing found an average of 9.9 and 9.4% of soluble solids, respectively, being observed that throughout the storage days values increased, these values can be related to the concentration of solids due to the loss of water in the tissue during the thawing process. Teixeira et al. [44] when studying the utilization of green coconut albumen in the making of smoothies found an average of 7.5% of soluble solids. According to Tucker [47] the accumulation of sugars are among the many vital processes that occur in fruits during ripening, according to the author, the concentration of sugars are the main respiratory substrates used for energy obtaining in the process of growth, maturation, and ripening of the fruits, and could have relation to such high soluble solid content.

As for the contents of ascorbic acid (Chart 2), there was no significant difference ($p \geq 0.05$) in the treatment with mulch in the five irrigation frequencies where ascorbic acid values ranged from 4.3 to 7.4 mg/100 g, as for the treatment without mulch, only IF2 differed from the other frequencies, where the contents of ascorbic acid ranged from 4.3 to 5.4 mg/100 g, this difference can be related to the oxidation of vitamin C. Penha [48] when assessing the characteristics of green coconut for water and pulp industrialization found an average of 8.27 mg/100 g, being higher than the one found in the present research.

There was no significant difference ($p \geq 0.05$) (Chart 2) in the treatments with and without mulch in the five irrigation frequencies for the SS/AT ratio, where for the treatment with mulch the ratio ranged from 7.8 to 10.9, and the treatment without mulch showed results ranging from 6.2 to 12.8. Dwarf green coconut pulp had a good performance in the SS/AT ratio, which led to the sweetness of the final product.

There was no significant difference ($p \geq 0.05$) in the contents of phenolic compounds in the pulp of dwarf green coconut in the treatment with mulch in the five irrigation frequencies, where the average ranged from 39.7 to 55.0 mg/100 g, as for the treatment without mulch, only IF3 differed from the others, obtaining averages of 28, to 41.4 mg/100 g. Teixeira et al. [44] when studying the utilization of green coconut pulp in the making of smoothies found an average of 18.82 mg/100 g for phenolic compounds, being lower than the ones found in this research.

4. CONCLUSIONS

Use of mulch enabled the coconut to obtain higher ratio values SS/TA, regardless of irrigation interval, very important from a commercial point of view and acceptance of water. In the pulp, greater prominence was observed for the phenolic compounds of the fruits treated with the use of mulch and independent of the irrigation shift.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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