J Food Sci Nutr Res 2019; 2 (2): 108-127 *DOI: 10.26502/jfsnr.2642-11000013*

Research Article

Stabilization and Sensory Evaluation of Cashew Apple Juice (*Anacardium occidentale* L.) from the Northeast Region in Côte d'Ivoire

Adou Marc[1*], Tetchi Fabrice Achille[1], Adjouman Yao Désiré[1,2], Amani N'Guessan Georges[1]

[1]Université Nangui Abrogoua, UFR des Sciences et Technologies des Aliments, 02 BP 801 Abidjan 02, Côte d'Ivoire

[2]Centre Suisse de Recherches Scientifiques en Côte d'Ivoire (CSRS), 01 BP 1303 Abidjan 01, Côte d'Ivoire

***Corresponding Author:** Adou Marc, Université Nangui Abrogoua, UFR des Sciences et Technologies des Aliments, Abidjan 02, Côte d'Ivoire, Tel: +225 48794109; E-mail: adou_marc@yahoo.fr

Received: 06 May 2019; **Accepted:** 16 May 2019; **Published:** 23 May 2019

Abstract

The aim of this work is to study the stability under predefined conditions of cashew nut juice and its sensory evaluations. Cashew apple juices have a pleasant taste and are generally marketed as frozen pulp, juice and nectar. This study examined the stability of the different samples of pasteurized cashew apple juice at 75°C/5 min and 90°C/30s and stored at different temperatures. Parameters such as pH, acidity, Refractometric Dry Extract (ESR), total sugar content, reducing sugars, vitamin C and microbiological analysis were determined on the juices. Pasteurization scales and storage time have shown a significant influence on the evolution of these parameters. Thus, the evolution of pH, acidity and ESR is due to the degradation of total sugars, reducing sugars and vitamin C used as substrates in the various reactions. Of these substrates studied, vitamin C is the compound that degrades most rapidly. Microbiological analysis also revealed the absence of total and fecal coliforms. The sensory evaluation showed that physicochemical and to a lesser extent microbiological variations in the environment did not influence the assessment of the juice samples. In short, the pasteurization rate of 75°C/5 min and the storage time for 5 days can be retained for a better preservation of the physicochemical characteristics. Thermal treatment, notwithstanding the degradation caused by vitamin C, appears to be an effective way of preserving cashew apple juice.

Keywords: Cashew apple; Cashew apple juice; Pasteurized juice; Stabilization; Vitamin C

1. Introduction

The cashew tree (*Anacardium occidentale* L.) comes from some countries in Latin America and can be found in West Indies. It has been naturalized in several tropical countries in Asia and Africa, including Côte d'Ivoire [1]. The nut (real fruit) is the most important product of the cashew tree. The cashew tree has now become a booming cash crop and represents a great opportunity for Africa in terms of exporting its nuts [2]. This tree was introduced in the 1960s and 1970s in northern Côte d'Ivoire, a region which is considered as a serious cattle breeder [3]. Over the last 5 years, that is (2013-2017), cashew nut production in Côte d'Ivoire has moved from 513,000 tonnes to 711,000 tonnes [4]. According to FAO data, the cashew nut production in Côte d'Ivoire is estimated at 22% of worldwide production and represents 750 000 tonnes in 2018 [4]. This achievement in cashew nut production has made Côte d'Ivoire the world's leading producer and exporter in this domain. Currently and mostly produced for its nuts, cashew tree also provide people with its apples (pseudo fruit). It is an enlarged stalk to which the nut is attached. The juicy cashew apple has a pleasant flavor and is generally marketed as frozen pulp, juice and nectar [5].

Cashew apples have been in the center of multitudinous scientific studies seeking to improve microbiological, organoleptic, nutritional quality and curative potential [2, 6-9]. It has the nutritional qualities for its richness in vitamin C and magnesium. It also has a technological interest thanks to its edible part between 85% and 100% with a juicy and sweet flesh, free of pips or stones [10]. In addition to that, cashew apple juice is 5 times richer in vitamin C than orange juice and 10 times richer in vitamin C than pineapple juice [11-13]. In health domain, cashew apple juice is considered as an excellent remedy for sore throats and chronic dysentery [14]. Phenolic compounds present in its breast provide effective protection against cardiovascular disease and certain cancers [15-16]. Despite its high nutritional potential, most of its production is abandoned at harvest sites. In fact, some taboos make people believe in a higher risk of food poisoning or even death due to the consumption of cashew nuts or their derivatives, milk and dairy products [2, 17-19]. Ivorian cashew apple production in 2015 was estimated at more than 6 million tonnes but was not exploited [20]. A better use of cashew apples, a by-product of walnut production will help to stabilize cashew tree exploitation. Besides, it will create new jobs and will hopefully help fight unemployment in Côte d'Ivoire [21]. Based on the use of many fruits, the main possible recovery method is to transform it into juice. However, in the case of cashew apples, this transformation process is confronted to three major obstacles. Firstly, there is the astringency of the juice due to the presence of condensed tannins. Secondly, we have the high thermo-sensitivity of the product both in nutrition and sensory aspects. Finally, we have the presence of sugar responsible for Maillard reactions during heat treatment [20].

Despite the fact that cashew apple juice is made of important nutrients [8, 13, 22-23], it has one weakness: its high alterability. This condition requires special maintenance in terms of pasteurization and storage [24]. Pasteurization deals with heat treatment to a temperature ranked among 60 and 100°C. In fact, it aims at destroying all non-spore-forming pathogenic microorganisms and, more significantly seeks at reducing the vegetative flora present in a product. It minimizes the biological activities of a product while preserving its organoleptic and nutritional

characteristics. The objective of this work is therefore to study the stability under predefined conditions of cashew apple juice and their sensory evaluations.

2. Materials and Methods

2.1 Material

The plant material consists in yellow and red cashew apple varieties from Bondoukou which is a Northeast production area in Côte d'Ivoire. Ripe cashew apples, fallen from the trees, were collected from cashew nut plantations during the walnut harvest period (March-May). These were sorted in order to only retain the intact ones, i.e. without any injury or rot. Then, they were transported to the laboratory. During the travelling time, they were put in coolers equipped with ice accumulators.

2.2 The pasteurization process

The pasteurization of cashew apple juice was carried out according to the method of Diop et al. [25]. The juices from the different cashew apples were distributed in glass containers (100 mL bottles). Using a water bath with thermostat and cover, the pasteurization temperatures were displayed. When the ideal temperature was stabilized, the bottles containing the cashew apple juice were immersed in the water bath for the predetermined pasteurization time. Thus, cashew apple juice was pasteurized according to two pasteurizations' scales which are 75°C for 5 min and 90°C for 30s. Pasteurized juice samples were stored at various temperatures to monitor the evolution of physicochemical and microbiological parameters. Storage temperatures are: laboratory temperature (22°C ± 1°C), refrigerator temperature (5°C ± 1°C) and freezer temperature (-18°C ± 1°C).

2.3 pH determination

The pH of apple juice was determined using a pH meter (pH meter C861, Consort, bio block, Belgium) according to the AOAC method [26]. The instrument was calibrated using two buffer solutions at pH 7.0 and 4.0 and this was systematically done before pH measuring. The measurement was made by immersing the electrode in 5 mL of sample and the reading is repeated three times.

2.4 Storage conditions and metered physicochemical parameters

Pasteurized cashew apple juice stored under different conditions was analyzed at predefined interval times (Table 1). The physicochemical parameters sought include total sugars, reducing sugars and vitamin C, which are substrate indicators. Then we have pH, acidity, ESR, which are the parameters for the environmental evolution. At the microbiological level, the health markers, that is, coliforms (total and thermo-tolerant) and mesophilic aerobic germs (GAM) were researched and quantified.

Pasteurization scale	**Unit**	**Storage temperature**	**Storage time**				
			T1	**T2**	**T3**	**T4**	**T5**
75°C/5 min	Hours	22°C	5	10	15	20	24

	Days	5°C	1	2	3	4	5
	Days	-18°C	20	40	60	80	100
90°C/30 s	Hours	22°C	5	10	15	20	24
	Days	5°C	1	2	3	4	5
	Days	-18°C	20	40	60	80	100

Table 1: Summary of storage conditions for pasteurized juice samples.

2.5 Microbiological analyses

2.5.1 Research of mesophilic aerobic germs (GAM): The search for mesophilic aerobic germs was performed on PCA (Plant Count Agar) agar. The stock solution was obtained by diluting 10 mL of cashew apple juice in 90 mL of sterile buffered peptone water in an Erlenmeyer. The mixture is homogenized for 30 to 60 s. Thus, the stock solution obtained was diluted to 10^{-2} and 10^{-3}. The enumeration of mesophilic aerobic germs was carried out using the technique of seeding the mass with PCA agar or standard canned agar at 30°C after 72 ± 3 h incubation. The number of colonies obtained is expressed as a function of the corresponding dilution with reference to NF ISO 4833 and NF V 08-051.

2.5.2 Research and enumeration of Total and Thermo-tolerant Coliforms: The search and enumeration of total coliforms were performed on LRV agar at 30°C for 24 ± 1 h incubation time according to NF ISO 4832. While using a sterile pipette, 10 mL of cashew nut juice was collected and dissolved in an Erlenmeyer containing 90 mL of buffered peptone water. The mixture is homogenized for 30 to 60 s. Thus, the stock solution obtained is diluted to 10^{-2} and 10^{-3}. The search for total and heat-tolerant coliforms was performed using the technique of inoculation into the mass of canned LRV agar at 30°C after 72 ± 3 h incubation and at 44°C for heat-tolerant coliforms. For the reading, red colonies with a diameter greater than or equal to 0.5 mm were counted and the result was expressed taking into account the dilution.

2.6 Sensory analysis of cashew apple juice

The sensory evaluation of the organoleptic characteristics of apple juice samples was carried out at the "Laboratoire National de la Santé Publique" (LNSP) in Abidjan, Côte d'Ivoire. A hedonic test on a linear 9-point scale (Table 2) assessed the degree of appreciation of organoleptic characteristics. This study was carried out using the method described by Stone and Sidel [27]. It was applied more specifically to cashew nut juice by Talasila et al. [28].

Color								
Extremely discolored	Very discolored	Discolored	Rather (quite) discolored	Nor discolored nor colored	Rather colorful	Colored	Very colored	Extremely colorful
1	2	3	4	5	6	7	8	9

Taste								
Extremely bitter	Very Bitter	Bitter	Rather (quite) bitter	Neither bitter nor sweet	Rather sweet	Sweet	Very Sweet	Extremely sweet
1	2	3	4	5	6	7	8	9
Odour								
Extremely unpleasant	Very unpleasant	Unpleasant	Rather (quite) unpleasant	Neither unpleasant nor pleasant	Rather pleasant	Pleasant	Very pleasant	Extremely pleasant
1	2	3	4	5	6	7	8	9
Decantation								
Extremely unpleasant	Very unpleasant	Unpleasant	Rather (quite) unpleasant	Neither unpleasant nor pleasant	Rather pleasant	Pleasant	Very pleasant	Extremely pleasant
1	2	3	4	5	6	7	8	9
Overall assessment								
Extremely unpleasant	Very unpleasant	Unpleasant	Rather (quite) unpleasant	Neither unpleasant nor pleasant	Rather pleasant	Pleasant	Very pleasant	Extremely pleasant
1	2	3	4	5	6	7	8	9

Table 2: 9-point hedonic scale.

2.6.1 Tasting panel: A thirty (30) people panel was set up. This panel was made up of people who had not been trained in the chosen characteristics. It was therefore suitable to test the acceptability of the different samples of pasteurized apple juice (75°C/5 min and 90°C/30 s) and stored at different storage temperatures (22°C and 5°C).

2.6.2 Scorecard sheet: The assessment of cashew nut apple juice samples was based on colour, flavor, odor, decanting and overall assessment. It has been realized using a linear hedonic scale. This nine-point scale, was ranged from “extremely poor” (points 1) to “extremely good” (points 9) [28-29]. As far as the color was concerned, the range varied from “extremely discolored” to “extremely colored”. And this was done for yellow apple juice. From “extremely less red” to “extremely red”, the action was performed for red apple juice. For the taste’s turn, the range was from “extremely bitter” to “extremely sweet”. Now, concerning the odor, the range varied from “extremely unpleasant” to “extremely pleasant”. For the settling, the range varied from “extremely unpleasant” to “extremely pleasant”. Finally, concerning the overall assessment, Things were done from “extremely unpleasant” to “extremely pleasant”.

2.6.3 Preparation and presentation of juice samples: The samples packaged in glass bottles, were pasteurized and then stored. The evaluation tests were conducted in a ventilated room, free of odors and other disruptions that could affect the panel's perception. Acceptability tests were conducted under white light. The samples were separately served, one by one to each taster using transparent glasses and seeking anonymity. A scoring sheet was given to each taster in order to increase their acceptance level.

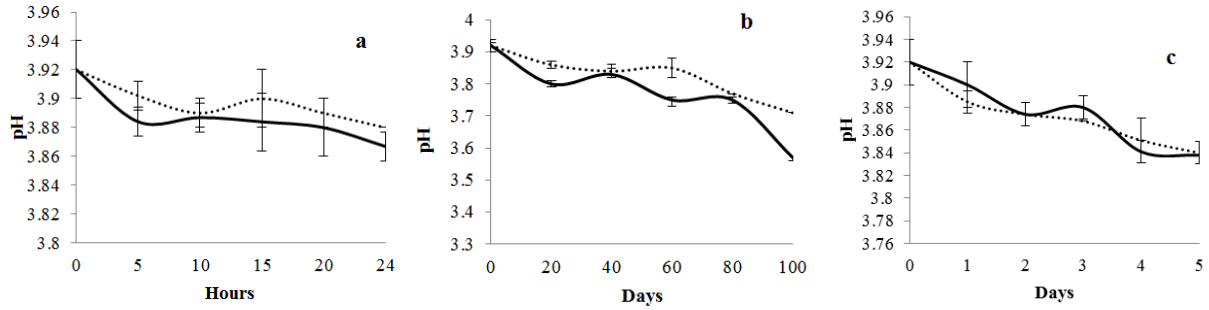
2.7 Statistical analysis

The data generated by this study was statistically processed with the SPSS 11.19 statistical software. The significance of the parameters resulting from the characterization was assessed by the Duncun test at 5% threshold. Firstly, the analysis of the variance (ANOVA) allowed us to process data from the evaluation of biochemical and hematological parameters and secondly, data from the sensory analysis of cashew apple juice. Although a major difference ($\alpha<0.05$) is revealed, the ANOVA test is supplemented by Turkey's post ANOVA test to identify the variable(s) with very significant differences from the control values.

3. Results

3.1 pH variation

The stability study of cashew apple juice is focused on yellow apple juice from Bondoukou. The pH evolution of cashew apple juice samples varies according to the pasteurization scale (75°C/5 min and 90°C/30 s), the storage temperature and the storage time (Figure 1). The samples were stored for 24 hours, 5 days and 100 days respectively. In general, this evolution is marked by a decrease in pH under the three storage conditions. In juice samples, pasteurized and stored at 22°C ± 1°C, the pH increased from 3.92 to 3.87 for samples pasteurized at 75°C and from 3.92 to 3.88 for samples pasteurized at 90°C. For cashew apple juice samples stored at 5°C ± 1°C, the pH increased from 3.92 to 3.83 for pasteurized juice samples at 75°C and from 3.92 to 3.84 for pasteurized juice samples at 90°C. The pH evolution of juice samples stored at -18°C ± 1°C is similar to the other two storage conditions, which are marked by a decrease. Thus, the pH values increase from 3.92 to 3.57 for samples of pasteurized juice at 75°C and from 3.92 to 3.71. There is no significant difference ($p<0.05$) between the pH variations of the juice stored at different temperatures.



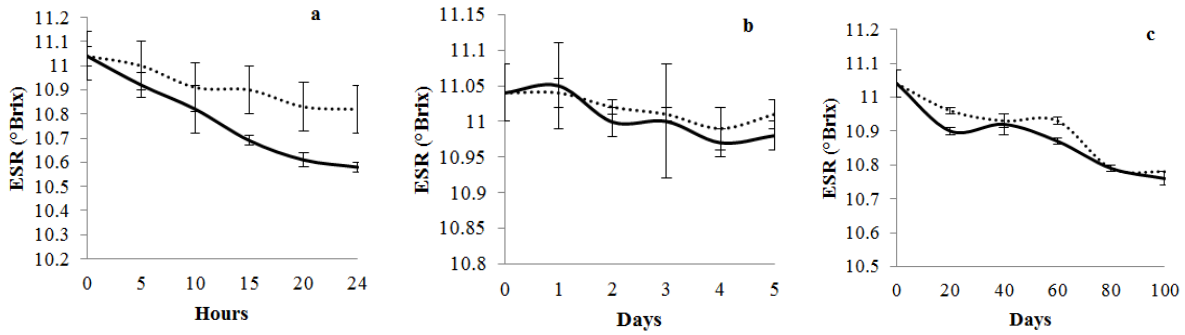
——— pH of the juice at 75°C;------- pH of the juice at 90°C

Figure 1: Variation in pH of cashew apple juice stored at (a) 22°C; (b) 5°C and (c) -18°C.

3.2 Variation in the ESR

The evolution of the Refractometric Dry Extract (ESR) of juice samples stored at different temperatures (22°C ± 1°C; 5°C ± 1°C; -18°C ± 1°C) is marked by a decrease for all the samples (Figure 2). The variations in the ESR is 11.04 to 10.58°Brix and 11.04 to 10.82°Brix respectively, for samples pasteurized at 75°C and those pasteurized at 90°C. At the storage temperature of 22°C, the decrease in ESR is rapid during the 24-hour storage period for samples pasteurized at 75°C. The values have thus increased from 11.04 to 10.58°Brix. This decrease is less rapid for samples pasteurized at 90°C. In samples stored at 5°C, the evolution is always marked by a decrease in ESR but less marked compared to the first case. This evolution is done in 3 phases, including a phase of a slight increase in ESR in samples pasteurized at both scales. Then, comes a phase of decline, punctuated by oscillation and followed by a final recovery phase for the ESR. Thus, in samples pasteurized at 75°C, the ESR values varied from 11.04 to 10.98°Brix with a peak decrease at 10.97°Brix.

For those pasteurized at 90°C, the values are between 11.04 and 11.01°Brix with a peak decrease to 10.99°Brix. The various variations recorded are not statistically significant ($p<0.05$). However, the decrease in the ESR of samples pasteurized at 75°C is more marked than that of samples pasteurized at 90°C. For juice samples stored at -18°C, the evolution is similar to the 2 other storage conditions, i.e. a decrease in ESR. Thus, in samples pasteurized at 75°C, the ESR values varied from 11.04 to 10.76°Brix and for those pasteurized at 90°C, the values varied from 11.04 to 10.78°Brix. This decrease is punctuated by oscillation with peaks of 10.92°Brix and 10.93°Brix respectively, for samples pasteurized at 75°C and those pasteurized at 90°C. These variations are not statistically significant ($p<0.05$) for the different samples stored at -18°C. As with samples stored at 5°C and 22°C, the decrease in ESR of samples pasteurized at 75°C is faster than the decrease in ESR of samples stored at 90°C.



——— °Brix of juice at 75°C; ---------°Brix of juice at 90°C

Figure 2: Variation of the Refractometric Dry Extract (ESR) of cashew apple juice stored at (a) 22°C; (b) 5°C and (c) -18°C.

3.3 Variation of titratable acidity

The Titratable acidity of the various pasteurized juice samples stored at the temperatures of this study decreases over time (Figure 3). It varies from 0.71 to 0.64% and from 0.71 to 0.66% respectively for samples pasteurized at 75°C