

## Quality Characteristics of Cashew Apple Juice as Affected by Pre-Treatment Techniques

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### ABSTRACT

Cashew apples deteriorate easily when kept for a few hours after plucking. The astringency of cashew apples has also limited its utilization and overall acceptability. This study, therefore, evaluated the effect of pretreatments on the quality of cashew juice. Fresh cashew apples were cleaned and pre-treated by blanching at 50 °C, 60 °C, 70 °C and 80 °C for 20 minutes and another batch of cashew apples was dipped in a brine of 5% concentration (w/v) at 80 °C for 20 minutes. Then, cashew juice was extracted from pre-treated apples and subjected to physicochemical, vitamins, minerals, anti-nutrient, and sensory analysis. The cashew apple blanched at 70 °C had the highest total solid, pH, and brix with the values 14.16%, 4.27, and 11.30 respectively. All these values differed significantly from the untreated samples except the brix. Samples blanched at 80 °C had the

highest vitamins A and B<sub>1</sub> (0.192 and 0.26 mg/100 g) and cashew apples blanched at 50 °C had the highest vitamins B<sub>2</sub>, B<sub>3</sub>, and C (0.68, 0.29, and 69.00 mg/100 g) which differed significantly from the untreated sample. The potassium, calcium, iron, and zinc ranged from 137.27 to 312.14 mg/100 g, 235.78 to 510.32 mg/100 g, 17.86 to 40.77 mg/100 g, and 0.22 to 0.55 mg/100 g, respectively. All treated samples had significantly higher mineral composition than the untreated cashew apple juice. The anti-nutritional factor ranged from 1.12 to 1.39 mg/100 g for total phenol, 0.12 to 0.28 mg/100 g for flavonoid, and 0.67 to 0.83 mg/100 g for tannin. Both treated and untreated cashew apple juice had no coliform. The result of the sensory evaluation showed that brine-treated juice had a higher acceptability value than other samples. Hence, pre-treatments of cashew apples enhanced the mineral and vitamin contents of the juice and increased the general acceptability.

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**Keywords:** Antinutritional factor, Cashew apple, Juice, Pre-treatment, Quality.

### INTRODUCTION

Juice is a drink made from extracting or pressing the natural liquid contained in fruits and vegetables. Fruit juices are critically good for all age categories as

they form an essential portion of a healthy diet and promote detoxification in the human body (Dèdéhou *et al.*, 2015). Further, this liquid extract is a rich source of vitamins and some minerals. Cashew (*Anacardium occidentale* L.) is native to Brazil and belongs to the Anacardiaceae family, which also includes many trees such as mango and pistachio (Akinhanmi *et al.*, 2008). Cashew is a cash crop in most tropical countries. The cashew tree is an economic crop in Africa including Nigeria. The tree produces soft, lustrous, fibrous but juicy fruit called the cashew apple, which has a single-seeded nut at the bottom enclosed in a tough, grey shell. Cashew apples are found in three colours; bright red, yellow, and orange (Rico *et al.*, 2016; Das and Arora, 2017). A fully mature or ripened cashew apple is juicy and firm with, a strong exotic flavour, high astringency, and high sugar concentration (Preethi *et al.*, 2019).

In some countries, the cashew apple is marketed as frozen pulp, nectar, and juice (Marc *et al.*, 2019). However, in Nigeria, the fruit is mostly consumed in raw form (Bolarinwa *et al.*, 2022). Cashew products possess high nutritional and medicinal properties. The apples and the kernels are loaded

with antioxidants, phenolics, organic acids, carotenoids, carbohydrates (mainly reducing sugars), minerals, vitamins, and amino acids (Kyereko *et al.*, 2023). The medicinal potentials of cashew apples include their ability to cure certain diseases like scurvy, diarrhea, uterine complaints, and rheumatism. It is also employed for the treatment of neurological pain and serves as a source of energy (Runjala and Kella, 2017).

The cashew apple is a rich source of antioxidants. It contains a relatively higher amount of vitamin C (262 mg/100 ml) which is three times more than values obtained in citrus (Oliveira *et al.*, 2020). It is a good source of calcium, phosphorus, and iron; it has a significant amount of amino acids such as alanine, aspartic acid, glutamic acid, serine, threonine, phenylalanine, leucine, tyrosine, and proline (Kyereko *et al.*, 2023).

Cashew apples deteriorate easily when kept for a longer period and not processed after a few hours of plucking (Das and Arora, 2017). Despite having high nutritional content, its astringent taste caused by the polyphenols, particularly the tannins is an unfavorable sensory attribute that

limits its acceptability for consumption and this leads to post-harvest losses of the apple. This study, therefore, investigated the effect of different pretreatments on the quality of cashew juice.

## **MATERIALS AND METHODS**

### ***Materials***

Fresh, ripened, juicy, matured, and good-quality cashew fruits were harvested from the Faculty of Agricultural Science research farm at Ladoké Akintola University of Technology, Ogbomoso, Nigeria. Extraction and laboratory analyses were done at Ibrahim Owoduni Food Processing Laboratory, Ladoké Akintola University of Technology, Ogbomoso, Nigeria.

### ***Sample Preparation***

The harvested cashew apples were divided into three batches. Then, apples were washed thoroughly using distilled water to remove adhering dirt. The first batch was sub-divided into four parts (each part had forty cashew apples) and blanched differently at 50 °C, 60 °C, 70 °C, and 80 °C for 20 minutes before the extraction process.

The second batch (forty cashew apples) was dipped in 5% brine solution for 20 minutes at 80 °C before the extraction of the juice and the last batch (forty cashew apples) served as control.

### ***Juice Extraction***

The cashew apples were detached from the nuts before the extraction of the cashew apple juice. The cashew apples were washed with clean water, and then cut and crushed by a blender. The juice was obtained by pressing the blended cashew apple through a 0.5 mm mesh screen. The juice was extracted from the blanched and the brine-treated cashew apples in the same way. The extracted juice samples were subjected to analyses.

### ***Analyses***

#### ***Chemical Composition***

The pH of the extracted juice was determined using a digital pH meter (Jenway 3510, 120 VA), (AOAC, 2010). The Brix value was estimated using a refractometer. The measuring prism of the refractometer was cleaned using cotton wool, the juice sample was added to the surface and it was covered with the flap. Then, the readings were

taken by viewing through the lens on the other end and were recorded (AOAC, 2010).

Titrateable acidity was evaluated according to the procedure given by AOAC (2010). Ten millilitres of the juice sample were pipetted into a conical flask and 25 ml of distilled water was added. Then, 200 ml of 0.1 M NaOH was poured into the burette and was titrated against the sample in the flask using 3 drops of phenolphthalein as an indicator.

### ***Total Solid***

Five grams of the sample was weighed into the dish and the weight was taken again. The dish without the lid was placed inside a boiling water bath until the water was evaporated from the sample, the base of the dish was wiped off and placed inside the oven at 102 °C for 2 h. The dish was placed inside the desiccator to cool. The weight of the dish was recorded. The heating and re-weighing process continued at hourly intervals until successive weighing did not vary by more than 0.05 mg (AOAC, 2010). The percentage (%) total solid of the cashew juice was calculated using the equation 1 below.

$$\%Total\ solid = \frac{Weight\ of\ residue}{Weight\ of\ the\ sample} \times 100 \quad (1)$$

### ***Determination of Ascorbic Acid***

Vitamin C was determined using the method of Beltrán-González *et al.* (2008) which is the iodine titration method. Twenty-five milliliters of juice were poured into a 150 ml beaker; 35 ml of starch sulphuric acid solution was added. The resulting solution was titrated with a standardized 0.1 m iodine solution (covered from light), and it was stirred until the first stable blue colour appeared. The juice was replaced with distilled water for the blank titration.

### ***Determination of Minerals***

Fifteen milliliters of the cashew juice were digested for mineral analysis following the procedure of AOAC (2010). The juice was treated with 5 ml of 65% Nitric acid in the Pyrex tube and the tube was heated in digestion blocks for 180 min at 130 °C. The solution was cooled at room temperature, transferred to a 25 ml volumetric flask, and topped up to the mark with deionized water. Levels of potassium, calcium, iron, and zinc were determined using an atomic absorption

spectrometer (Spectra AA 200FS). Minerals were analyzed in three replicates.

### ***Determination of the Antioxidant Properties***

#### *Total Phenolic Content*

The total phenolic content was analyzed using the Folin-Ciocalteu reagent, following a modified procedure of Singleton *et al.* (1999). Samples were appropriately diluted with methanol to give 80% aqueous methanol. One milliliter of the diluted sample was mixed with 5 ml of Folin-Ciocalteu reagent (1:10, v/v, diluted with distilled water). The reaction was neutralized by adding 4 ml of 75 g L<sup>-1</sup> sodium carbonate. Samples were held for 2 h at 25 ± 2°C. Absorbance was read at 765 nm after being allowed to stand for 20 min at room temperature.

#### *Determination of Flavonoid*

For flavonoid determination, five grams of sample were boiled in 50 mL of 2 mol/L HCl solution under reflux for 30 min. After cooling, the contents were filtered through a Whatman No. 42 filter paper. Five milliliters of the extract were mixed gradually with an

equal volume of ethyl acetate. The precipitate was recovered by filtration using pre-weighed filter paper. The resulting weight difference gave the weight of the flavonoid in the sample

### ***Determination of the Anti-nutrient Properties***

Tannin, phytate, and saponin contents were determined as described by Ijarotimi *et al.* (2013).

#### *Determination of Tannin*

Tannin content was determined by measuring 0.2 g of the sample in a 50-mL beaker. Twenty milliliters of 50% methanol were added to the sample and mixed thoroughly to prevent lumping. The mixture was filtered, and mixed with distilled water to make up to mark in a 100 mL volumetric flask. One milliliter of the sample extract was added with 20 mL distilled water, 2.5 mL Folin-Denis reagent, and 10 mL of 17% Na<sub>2</sub>CO<sub>3</sub>. After the mixture was allowed to stand for 20 min for a bluish-green colouration to develop, the absorbance was read at a wavelength of 760 nm on a Spectronic 21D spectrophotometer.

### *Determination of Saponin and Phytate*

Saponin was determined using the spectrophotometric method and absorbance was read at a wavelength of 380 nm while the absorbance for quantification of phytate was read at 480 nm.

### *Microbial Analysis*

#### *Total Viable Count*

The total viable count was obtained by the pour plate method using nutrient agar as the growth medium. One milliliter of the diluent was poured into sterile Petri dishes and 10 ml of the nutrient agar was gently dispersed on it. The plate was swirled gently and inverted after it had solidified. The plates were inverted and incubated at 37 °C for 24 h. The colonies were counted and the number of colonies per plate was multiplied by the dilution factor to obtain the total viable count per ml of the original sample.

Mac Conkey agar medium was used for the enumeration of coliform bacteria. The specified dilutions were gently poured into the medium and spread over the surface of the agar, the

dishes were then inverted and incubated at 37 °C for 48±2 h.

Yeast extract agar medium was used for the enumeration of yeast and moulds. The specified dilutions were deposited on the solidified medium and spread over the surface of the agar, the dishes were inverted and incubated at 25°C for 5 days.

#### *Sensory Analysis*

The method described by Granato *et al.* (2012) was used for the sensory evaluation of the cashew apple juice. The sensory evaluation was performed by fifty semi-trained panelists. The colour, taste, appearance, flavour, and overall acceptability of cashew juice were evaluated using a nine-point hedonic scale.

#### *Statistical Analysis*

Statistical analysis was performed using Statistical Package for Social Science (SPSS) version 20.0 Software. Data were analyzed using analysis of variance and means were separated with the new Duncan multiple range test.

## RESULTS AND DISCUSSION

### *Physicochemical Properties of Cashew Apple Juice*

The physicochemical properties of cashew apple juice are presented in Table 1. The titratable acidity of the cashew apple juice ranged from 0.03 to 0.04%. The brine-treated sample and all heat-treated juice samples had the same titratable value of 0.04% except the blanched sample at 80 °C which had the lowest value of 0.03% and was the same as the control sample. However, there was no significant difference between the samples. The value obtained in this

study is lower than that of apple juice (0.90 to 0.97%) reported by Liberato *et al.* (2021). Titratable acidity is a measure of total acid concentration in juice and it is a determinant of how organic acid in the juice impact flavour (Tyl and Sadler, 2017).

The total solid of the cashew juice ranged from 6.00 to 14.16%. Juice blanched at 80 °C and the control had the same value while juice blanched at 70 °C had the highest total solid. There was a significant ( $p < 0.05$ ) difference between all the samples. It was evident that heat treatment increased total solids as a result of moisture removal.

**Table 1:** Physicochemical properties of cashew apple juice

Sample	TTA (%)	Total Solid (%)	pH	Brix
A	0.04±0.00 <sup>a</sup>	10.00±0.05 <sup>b</sup>	4.01±0.01 <sup>a</sup>	10.27±0.15 <sup>a</sup>
B	0.04±0.00 <sup>a</sup>	13.76±0.11 <sup>c</sup>	4.07±0.01 <sup>b</sup>	11.16±0.05 <sup>b</sup>
C	0.04±0.00 <sup>a</sup>	14.16±0.12 <sup>c</sup>	4.27±0.01 <sup>d</sup>	11.30±0.10 <sup>b</sup>
D	0.03±0.00 <sup>a</sup>	6.00±0.10 <sup>a</sup>	4.12±0.01 <sup>c</sup>	11.20±0.10 <sup>b</sup>
E	0.04±0.00 <sup>a</sup>	8.76±0.05 <sup>b</sup>	4.15±0.01 <sup>c</sup>	10.33±0.57 <sup>b</sup>
F	0.03±0.00 <sup>a</sup>	6.00±0.10 <sup>a</sup>	4.14±0.01 <sup>c</sup>	10.66±0.57 <sup>ab</sup>

Means ( $\pm$  standard deviation) within the same column with different superscripts are significantly ( $p < 0.05$ ) different. Sample A- Blanched at 50 °C; Sample B- Blanched at 60 °C; Sample C- Blanched at 70 °C; Sample D- Blanched at 80 °C; Sample E- Treated with brine; Sample F- Untreated (control).

However, if they are not promptly preserved in a cool place, microorganisms are likely to multiply in these juices and ferment them in a very short period of time due to their high moisture content (Adou *et al.*, 2021). The pre-treatment of cashew apple juice showed that heat-treated juice samples had significantly higher total solid than the untreated cashew apple except the cashew apple blanched at 80 °C. The pH values of cashew apple juice ranged from 4.01 to 4.27%. The cashew apple blanched at 80 °C and the one treated with brine was not significantly different from the control. The value obtained is similar to that of Adou *et al.* (2012) in their findings on the pH of cashew apple juice. Heat treatment must have caused the pH value of the juice to increase towards alkalinity. The cashew apple is an acidic fruit and this is evident in the report of Emelike and Ebere (2015) for untreated cashew apple juice with a pH value of 4.14. The cashew apple juice was observed to have a brix value ranging from 10.27 to 11.30°Bx. All the treated samples had a significantly higher value than the control except the sample blanched at 50 °C. Dèdèhou *et al.* (2015) observed brix values for

cashew juice ranged between 11 and 14 °Bx. This result is also within the range value (9.25 and 12.63%) obtained by Agbangnan *et al.* (2018) as reported for the total soluble solids of juices of two cashew apple varieties of Benin.

### ***Vitamin Composition of Cashew Juice***

The effect of different pre-treatment techniques on the vitamin of cashew apple juice is shown in Table 2. The values of vitamin A obtained from the cashew apple juice ranged from 0.051 to 0.192 mg/100 g. All the blanched samples had higher values of vitamin A than the control sample except the sample blanched at 70 °C. The brine-treated sample was significantly lower than other samples (0.051 mg/100 g) which is an indication that the salt solution reduced the vitamin A content. Sarkar *et al.* (2021) reported that blanching improved the stability of  $\beta$ -Carotene in cabbage when subjected to drying. Negi and Roy (2001) observed blanching as a pretreatment before drying minimized losses of beta-carotene during storage due to the inactivation of endogenous enzymes that can cause beta-carotene degradation.



**Table 2:** Vitamin contents of cashew apple juice

Sample	Vitamin A (mg/100 g)	Vitamin B <sub>1</sub> (mg/100 g)	Vitamin B <sub>2</sub> (mg/100 g)	Vitamin B <sub>3</sub> (mg/100 g)	Vitamin C (mg/100 g)
A	0.13±0.00 <sup>c</sup>	0.22±0.01 <sup>ab</sup>	0.68±0.00 <sup>d</sup>	0.29±0.01 <sup>c</sup>	69.00±0.50 <sup>c</sup>
B	0.186±0.03 <sup>d</sup>	0.23±0.01 <sup>ab</sup>	0.56±0.00 <sup>a</sup>	0.18±0.00 <sup>b</sup>	58.83±0.85 <sup>b</sup>
C	0.077±0.00 <sup>b</sup>	0.21±0.00 <sup>a</sup>	0.57±0.00 <sup>c</sup>	0.19±0.00 <sup>b</sup>	56.33±0.89 <sup>b</sup>
D	0.192±0.00 <sup>d</sup>	0.26±0.00 <sup>c</sup>	0.57±0.00 <sup>d</sup>	0.19±0.01 <sup>b</sup>	50.33±0.04 <sup>a</sup>
E	0.051±0.00 <sup>a</sup>	0.24±0.01 <sup>b</sup>	0.55±0.00 <sup>a</sup>	0.27±0.00 <sup>c</sup>	57.17±0.89 <sup>b</sup>
F	0.087±0.00 <sup>b</sup>	0.21±0.01 <sup>a</sup>	0.55±0.00 <sup>a</sup>	0.12±0.02 <sup>a</sup>	45.33±0.61 <sup>a</sup>

Means ( $\pm$  standard deviation) within the same column with different superscripts are significantly ( $p < 0.05$ ) different. Sample A- Blanched at 50 °C; Sample B- Blanched at 60 °C; Sample C- Blanched at 70 °C; Sample D- Blanched at 80 °C; Sample E- Treated with brine; Sample F- Untreated (control).

The values of vitamin B<sub>1</sub> in the cashew apple juice ranged from 0.21 to 0.26 mg/100 g. Increased Vitamin B<sub>1</sub> in all samples was observed except the sample blanched at 70 °C which had the same value as the control. The blanched sample at 80 °C had the highest value of 0.26 mg/100 g. The values gotten are observed to be lower compared to the value (2.30 mg/100 g) reported by Ukonze *et al.* (2018) for clarified cashew juice. The value of vitamin B<sub>2</sub> in the cashew apple juice ranged from 0.55 to 0.68 mg/100 g. The values of all the samples increased compared to the value of the control sample except the value of brine treated sample which had the same value as the control. Steam treated sample at 50 °C had the highest significant value of 0.68 mg/100 g while the steam-treated sample at 80

°C had the lowest value of 0.26 mg/100 g. The value is observed to be lower compared to the value (1.30 mg/100 g) reported by Ukonze *et al.* (2018) on the impact of the clarification process on the vitamin composition of cashew juice.

The value of vitamin B<sub>3</sub> in the cashew apple juice ranged from 0.12 to 0.29 mg/100 g. The blanched sample at 50 °C had the highest value of 0.29 mg/100 g while the control had the significantly lowest value of 0.12 mg/100 g. Blanching increased the vitamin B<sub>3</sub> content however, the vitamin B<sub>3</sub> reduced with increased blanching temperature. The value obtained from the analysis is in line with the value (0.12 mg/100 g) reported by Ukonze *et al.* (2018) on the impact of

the clarification process on the vitamin B<sub>3</sub> content of cashew (*A. occidentale*) apple juice. Vitamin C content ranged from 45.33 to 69.00 mg/100 g for juice blanched at 50 °C and the control. Vitamin C content in all the cashew apple juice was observed to be higher than the control. It was noticed that as the blanching temperature increased, the vitamin C content decreased. Vitamin C is a very unstable vitamin that can be denatured easily with heat treatment (Igwemmar *et al.*, 2013). Therefore, the higher temperature had a significant effect on the vitamin content of the cashew apple juice.

### *Mineral Composition of Cashew Apple Juice*

The results obtained from the analysis of the mineral composition of cashew apple juice are shown in Table 3. The value of potassium in the cashew apple juice ranged from 137.27 to 312.14 mg/100 g for juice blanched at 50 °C and the control. It was noted that there was a significant difference ( $p < 0.05$ ) between all the samples as there was a reduction in potassium content with increased blanching temperature. Also, the sample treated with brine had significantly higher potassium content than the control. The values obtained were discovered to be higher than the

**Table 3:** Mineral composition of cashew apple juice

Sample	K mg/100 g	Ca mg/100 g	Fe mg/100 g	Zn mg/100 g
A	312.14±0.01 <sup>f</sup>	412.63±0.16 <sup>d</sup>	35.53±0.00 <sup>d</sup>	1.63±0.15 <sup>d</sup>
B	260.60±0.00 <sup>d</sup>	510.33±0.01 <sup>f</sup>	32.53±0.00 <sup>c</sup>	0.83±0.00 <sup>b</sup>
C	236.40±0.10 <sup>c</sup>	460.73±0.15 <sup>e</sup>	40.43±0.01 <sup>e</sup>	1.07±0.00 <sup>c</sup>
D	162.80±0.10 <sup>b</sup>	336.63±0.15 <sup>b</sup>	40.77±0.00 <sup>f</sup>	2.55±0.01 <sup>f</sup>
E	286.95±0.01 <sup>e</sup>	386.33±0.11 <sup>c</sup>	31.42±0.00 <sup>b</sup>	1.97±0.00 <sup>e</sup>
F	137.27±0.00 <sup>a</sup>	235.78±0.00 <sup>a</sup>	17.86±0.00 <sup>a</sup>	0.22±0.00 <sup>a</sup>

Means ( $\pm$  standard deviation) within the same column with different superscripts are significantly ( $p < 0.05$ ) different. Sample A- Blanched at 50 °C; Sample B- Blanched at 60 °C; Sample C- Blanched at 70 °C; Sample D- Blanched at 80 °C; Sample E- Treated with brine; Sample F- Untreated (control).

values reported by Olalusi *et al.* (2020) for cashew juice. Blanching at a lower temperature (50-60 °C) gave a higher value of potassium than samples treated at a higher temperature.

The value of calcium in the cashew apple juice ranged from 235.78 to 510.33 mg/100 g for cashew apple blanched at 60 °C and the control. The most abundant mineral in the juice sample was calcium and heat-treated samples had higher values. The result obtained was higher than the value reported by Olalusi *et al.* (2020). For healthy bodily growth, calcium is necessary. Osteomalacia, rickets, and osteoporosis are diseases brought on by a calcium deficit in the body. According to Okonkwo and Ozoude (2015), the presence of calcium in trace levels is crucial for preventing nutritional deficiency diseases.

The iron content of the cashew apple juice ranged from 17.86 to 40.77 mg/100 for the blanched sample at 70 °C and the control. The result obtained in the study is higher compared to the value of Emelike *et al.* (2015) on defatted and un-defatted cashew kernel flour. A deficiency of iron will lead to anemia. This shows that the iron level of the juice is higher than the amount found in

the kernel. As a result, cashew juice can help individuals consume the recommended amount of iron, which is essential for maintaining good health (Okonkwo and Ozoude, 2015). The zinc content of the cashew apple juice ranged from 0.22 to 2.55 mg/100 g for the blanched sample at 80°C and the control. There was a significant difference of ( $p < 0.05$ ) between all the samples. Regardless of pretreatment, cashew apple juice has a low zinc content.

#### ***Effect of Pre-treatment on the Antioxidant and Anti-nutritional Properties of Cashew Apple Juice***

The antioxidant and anti-nutritional properties of pre-treated cashew apple juice are shown in Table 4. The total phenol content of the juice ranged from 1.12 to 1.39 mg/100 g. Control had the highest value while the sample blanched at 60°C had the lowest value. It was observed that heat treatment significantly ( $p < 0.05$ ) reduced the total polyphenols of juice. Babalola *et al.* (2021) reported that blanching reduced the total phenolic content of leafy vegetables while higher values were documented in the unblanched samples. Leaching, which happens when heat disrupts a plant's cell wall,

has been linked to the drop in polyphenols during blanching (Olayinka *et al.*, 2012). The authors also observed that the lower the temperature of drying of vegetables, the higher the total phenol as a higher value was also observed in samples blanched at 50 °C.

The content of flavonoids ranged from 0.12 to 0.24 mg/100 g. The blanched sample at 80 °C had the highest value while the brine-treated sample had the lowest value. The findings revealed that cashew apples are an excellent source of flavonoids, and flavonoids plants derived from plant sources have been linked to biological benefits such as a decreased

risk of cancer and cardiovascular disease (Panche *et al.*, 2016). The content of tannin in the juice ranged from 0.67 to 0.83 mg/100 g for the blanched sample at 50 °C and the control. It was observed that the result obtained from this research is higher than the value reported by Akinnibosun and Oyetayo (2018) when cashew apple residue was subjected to soaking and blanching. The presence of tannin is the reason for the astringent taste of the cashew apple (Olalusi *et al.*, 2020). Tannins prevent the digestive tract and other systems from using some minerals and proteins to their full potential (Santos-Lima *et al.*, 2012).

**Table 4:** Anti-oxidant and Anti-nutritional properties of cashew apple juice

Sample	Total Polyphenol (mg/100 g)	Flavonoid (mg/100 g)	Tannin (mg/100 g)	Phytate (mg/100 g)	Saponin (mg/100 g)
A	1.36±0.04 <sup>c</sup>	0.24±0.01 <sup>d</sup>	0.83±0.04 <sup>b</sup>	0.23±0.02 <sup>bc</sup>	0.15±0.01 <sup>bc</sup>
B	1.12±0.03 <sup>a</sup>	0.15±0.00 <sup>b</sup>	0.79±0.01 <sup>b</sup>	0.21±0.00 <sup>b</sup>	0.14±0.00 <sup>b</sup>
C	1.25±0.02 <sup>b</sup>	0.15±0.00 <sup>b</sup>	0.80±0.01 <sup>b</sup>	0.24±0.00 <sup>c</sup>	0.16±0.0 <sup>c</sup>
D	1.27±0.04 <sup>b</sup>	0.17±0.00 <sup>c</sup>	0.81±0.08 <sup>b</sup>	0.14±0.02 <sup>a</sup>	0.09±0.0a
E	1.22±0.06 <sup>b</sup>	0.12±0.00 <sup>a</sup>	0.73±0.05 <sup>ab</sup>	0.24±0.02 <sup>c</sup>	0.16±0.01 <sup>c</sup>
F	1.39±0.05 <sup>c</sup>	0.28±0.02 <sup>e</sup>	0.67±0.09 <sup>a</sup>	0.22±0.00 <sup>bc</sup>	0.14±0.00 <sup>bc</sup>

Means ( $\pm$  standard deviation) within the same column with different superscripts are significantly ( $p < 0.05$ ) different Sample A- Blanched at 50 °C; Sample B- Blanched at 60 °C; Sample C- Blanched at 70 °C; Sample D- Blanched at 80 °C; Sample E- Treated with brine; Sample F- Untreated (control).

The content of phytate ranged from 0.14 to 0.24 mg/100 g. It was observed that the treated sample at 70°C and the brine-treated sample had the highest value while the sample treated at 80 °C had the lowest value. The result obtained from this research work is noted to be higher than the value reported by Akinnibosun and Oyetayo (2018) for Nigerian cashew apple residue and there is a significant ( $p < 0.05$ ) difference between the samples. Phytates are found in almost all plants because it is the salts of phytic acid. They are regarded as chemicals in plants that bind with minerals, which makes minerals from food-containing phytates less likely to be absorbed by the body (Quinn *et al.*, 1975).

The content of saponin ranged from 0.09 to 0.16 mg/100 g. The blanched sample at 70 °C and the brine-treated sample had the highest value while the sample blanched at 80 °C had the lowest value. Heat treatment reduced the saponin content of the juice, especially with the sample blanched at 80 °C. Saponins react with cholesterol to reduce their activity in the body. They are haemolytic and are fatal when injected into the blood (Santos-Filho *et al.*, 2005).

### ***Microbial Quality of Cashew Apple Juice***

The result of the microbial analysis carried out on the effect of different pretreatment techniques on the quality of cashew apple juice is summarized in Table 5. The result revealed the presence of aerobic microorganisms, the value ranged from 1.00 to  $9.50 \times 10^3$  cfu/ml. The blanched sample at 80 °C had the highest microbial load while the control had the lowest microbial load with proportions below the standard ( $< 10^2$  CFU). The result also showed a reduction in yeast present in the juice sample where the untreated sample had the highest value and the blanched sample at 70 °C had the lowest value. There was no visible yeast growth on cashew apple juice blanched at 80 °C. The value for the total mould count ranged from 0.50 to  $1.00 \times 10^1$  cfu/ml where the blanched sample at 60 °C and 70 °C had the highest value. However, coliform was not found in all the samples this indicates that the cashew apple juice samples were produced hygienically. It was observed that the result obtained is in line with the result reported by Adou *et al.* (2012) on the microbial evaluation of cashew apple juice (*A. occidentale* L.) from the Northeast Region in Côte d'Ivoire.

### *Sensory Attributes of Cashew Apple Juice*

The results of the sensory evaluation carried out on the effect of different pre-treatments on the quality attributes of cashew apple juice are shown in Table 6. The score for colour of the cashew apple juice ranged from 4.20 to 7.80.

The brine-treated sample had the highest score while the control had the lowest score. A significant difference ( $p < 0.05$ ) existed between all samples. The score for the taste of the cashew apple juice ranged from 3.20 to 8.00.

**Table 5:** Microbial analysis on cashew apple juice

Sample	Total Aerobic Count (cfu/ml)	Total Yeast Count (cfu/ml)	Total Mold Count (cfu/ml)	Coliform Count (cfu/ml)
A	$1.35 \times 10^4$	$8.50 \times 10^1$	$0.50 \times 10^1$	-
B	$5.00 \times 10^3$	$1.65 \times 10^3$	$1.00 \times 10^1$	-
C	$7.50 \times 10^3$	$1.00 \times 10^1$	$1.00 \times 10^1$	-
D	$4.15 \times 10^4$	-	$0.50 \times 10^1$	-
E	$9.50 \times 10^3$	$3.10 \times 10^2$	$0.50 \times 10^1$	-
F	$1.00 \times 10^3$	$2.20 \times 10^4$ <sup>c</sup>	-	-

Means ( $\pm$  standard deviation) within the same column with different superscripts are significantly ( $p < 0.05$ ) different. Sample A- Blanched at 50 °C; Sample B- Blanched at 60 °C; Sample C- Blanched at 70 °C; Sample D- Blanched at 80 °C; Sample E- Treated with brine; Sample F- Untreated (control), -: No growth

The sample treated with brine had the highest score while the control had the lowest score. This implied that blanching at 80 °C is optimum for the taste of cashew apple juice. The score for the flavour of the cashew apple juice ranged from 3.30 to 7.75 for the brine-treated sample and the control. The overall acceptability value of the cashew apple juice ranged from 3.40 to

7.70. The brine-treated sample was the most acceptable among all the samples while the control was least accepted by the panelists. The heat treatment, as well as the brine treatment, did not negatively affect the quality of the juice samples according to the scores obtained.

**Table 6:** Sensory attributes of cashew apple juice

Sample	Colour	Taste	Flavour	Overall Acceptability
A	5.95±0.09 <sup>b</sup>	6.20±0.95 <sup>b</sup>	6.45±0.94 <sup>b</sup>	6.45±0.94 <sup>b</sup>
B	6.15±0.67 <sup>b</sup>	6.30±0.21 <sup>b</sup>	6.70±0.17 <sup>b</sup>	6.60±0.94 <sup>b</sup>
C	6.45±0.75 <sup>bc</sup>	6.40±0.99 <sup>b</sup>	6.40±0.68 <sup>b</sup>	6.60±0.75 <sup>b</sup>
D	6.90±0.91 <sup>c</sup>	6.55±0.88 <sup>b</sup>	6.85±0.74 <sup>b</sup>	7.00±0.64 <sup>b</sup>
E	7.80±0.61 <sup>d</sup>	8.00±0.91 <sup>c</sup>	7.75±0.63 <sup>c</sup>	7.70±0.73 <sup>c</sup>
F	4.20±0.95 <sup>a</sup>	3.20±0.95 <sup>a</sup>	3.30±0.92 <sup>a</sup>	3.40±0.94 <sup>a</sup>

Means ( $\pm$  standard deviation) within the same column with different superscripts are significantly ( $p < 0.05$ ) different. Sample A- Blanched at 50 °C; Sample B- Blanched at 60 °C; Sample C- Blanched at 70 °C; Sample D- Blanched at 80 °C; Sample E- Treated with brine; Sample F- Untreated (control).

## CONCLUSION

Pre-treatment improved the quality of cashew juice, blanched samples had higher Brix, total solid, and pH values. Pre-treatment of cashew apple enhanced the mineral and vitamin contents of the juice and heat did not affect the phytochemical properties of the cashew apple juice. Pre-treatments enhanced the vitamin C, vitamin B complex, and mineral contents of cashew juice than the untreated sample. Samples treated at 50 °C had the highest values of vitamin C, B<sub>2</sub>, and B<sub>3</sub>, and no significant difference was observed in the anti-nutritional factors of all the samples. There was no coliform count in all the samples and the value obtained for aerobic, mold, and yeast counts were within the recommended limit. Brine- treated samples had the

highest scores for all the sensory attributes evaluated. Therefore, pre-treatment of cashew apple should be employed in the production of cashew juice.

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