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EFFECT OF TREATMENTS ON THE TANNIN CONTENT AND QUALITY ASSESSMENT OF CASHEW APPLE JUICE AND THE KERNEL

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ABSTRACT: *Cashew (Anacardium occidentale L.) apple juice was processed using pasteurized apple (PA), pressure treated apple (PTA), gelatine treated apple (GTA), carbonate treated apple (CTA), salt treated apple (STA), hot water treated apple (HWTA) and unpasteurized apple (UPA) was used as the control sample. Cashew kernels were also processed using oil frying and oven drying techniques and the imported cashew kernel served as the control. The effect of these treatments and techniques on the physical, chemical, tannin and sensory properties were studied. The result of the juice samples showed pH range of 4.06 – 7.28 (HWTA and CTA), colour 3.08EBC – 7.50EBC (CTA and GTA), total solid 12.76 – 24.83% (PA and GTA), titratable acidity 0.03 – 1.97% (CTA and STA), crude protein 0.22 – 8.52% (STA, HWTA and GTA), ash 0.24 – 3.72% (STA and CTA), carbohydrate 6.17 – 8.62% (GTA and STA) and tannin 0.07 – 2.84mg/100ml (HWTA and PA), respectively. Hot water treatment significantly reduced the tannin content of the juice by 96.20%. HWTA juice was observed to maintain significantly high ($p<0.05$) sensory attributes of colour, taste, flavour, desirability and general acceptability (4.65, 4.21, 3.60, 4.27 and 4.73, respectively) and effectively reduced the astringency of the juice with the score of 2.53. Oil frying and oven drying techniques significantly did not affect all the chemical properties of the produced cashew kernel compare to the imported sample. The reduction of tannin in the cashew kernel was achieved using oil frying technique as regards to the imported sample by 0.1%. There was no significant difference ($p<0.05$) in all the sensory attributes between the oil fried and imported cashew kernels. From the analysis, the reduction of tannin content in cashew apple juice and cashew kernel was achieved by immersing the apple in hot water before juice expression and by frying the kernels in hot oil before the remover of tasta, respectively and still maintain the physical, chemical and sensory properties of the products.*

KEYWORDS: Cashew Apple, Cashew Kernel, Juice, Physical, Chemical, Sensory Properties

INTRODUCTION

Fruit juices are critically good for all age categories as it forms an important portion of a healthy diet and promote detoxification in the human body (Deanna and Bland, 2007). The main problem in nutritional exploitation of fruits is the presence of anti-nutritional and toxic properties. These factors are usually present in trace amount and they affect the nutritional potential of fruits as they impair the efficient utilization of nutrients (Umoh, 1998). Therefore, maintaining the quality of processed fruit juices is an important concern (Mathooko and Njiru, 1994) to industries and researchers. As such, many research articles have been written and published by different academic researchers which includes; ascorbic acid retention in canned lime juice preserved with sulphur dioxide and benzoic acid (Francis and Elizabeth, 2002); role of sodium benzoate as a chemical preservative in extending the shelf life of orange juice (Muhammad *et al.*, 2013); as well as effect of packaging materials, storage time and

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temperature on the colour and sensory characteristics of cashew apple juice (Emelike and Ebere, 2015a). Bates *et al.,* (2001) and Achal (2005) stated that preserved fruit juices commands a higher value and can be consumed more conveniently than whole fruits.

Cashew tree (*Anacardium occidentale L.*) is one of the major plantation crops grown in Nigeria. The fruit comprised mainly the nuts containing an embryo (kernel) and a false fruit known as cashew apple (Akinwale, 2000). Cashew apple juice is rich in sugar and vitamin C (Azevedo and Rodrigues, 2000); as well as antioxidant properties (Trevisan *et al.,* 2006; Kubo *et al.,* 2006). De-Carvalho *et al.,* (2007) stated that cashew apple juice has the potential to be a natural source of vitamin C and sugar in processed food. Cashew nut has a fine taste and a market potential. Most of the nuts produced in Nigeria are exported to other countries for processing. This attracts low prices in international market because of lack of adequate processing machines and high cost of machines' importation. Some estimates suggested that Nigeria and other African countries loose about one hundred million dollars per year by not processing their cashew nuts (Ogunmoyela, 1983). Raw cashew nut produced in Nigeria in 2007 was about 660,000MT and it was revealed that only 10% was utilized locally (FAO, 2008). The implication of this is that 90% was either wasted or exported unprocessed to foreign countries. Efforts made by many scientists to reduce the annual wastage of cashew products includes; compositional studies and physicochemical characteristics of cashew nut flour (Aremu *et al.,* 2006), proximate and mineral composition of roasted and defatted cashew nut flour (Vincent *et al.,* 2009), utilization of cashew kernel meals in the nutritional enrichment of biscuit (Aroyeun, 2009), minerals and bioactive compounds in cashew apple (Bhakyaraj and Singaravadive, 2012), physico-chemical and sensory properties of cookies prepared from wheat flour and cashew-apple residue as a source of fibre (Ebere *et al.,* 2015), as well as storage conditions on the vitamin C and pH value of cashew apple juice (Emelike and Ebere, 2015b). Cashew apples are rich in nutritive values such as vitamin C and minerals (calcium, iron, potassium) but it is not fully utilized or accepted as food because it contains high tannin content and astringent taste. Total tannin (hydrolysable) in cashew is about 0.64mg/100g while condensed tannin is about 0.18mg/100g. Both tannins are common protein binding and leather-forming activities. Apart from the ability to precipitate protein, tannin equally decreases digestibility and palatability (Osagie and Eka, 1998; Aliyu and Hammed, 2008). FAO (1992) reported that tannin binds protein, fights digestion by inhibiting key enzymes involved in digestion and renders iron and vitamin B_{12} unavailable. There is a need to eliminate or reduce the amount of tannin in the locally processed cashew kernel and cashew apple juice in order to ensure that all the nutrients are absorbed in the body system when they are consumed. As such, Emelike and Ebere (2015c) studied the influence of sand and gari roasting on the tannin content of cashew kernel and compared it with a reference sample (control). It was concluded that gari roasting method was effective in reducing the tannin content which compared well with the tannin content in the control cashew kernel.

Information on the tannin reduction of cashew apple juice (CAJ) and cashew kernel using different processing methods are limited. Hence, the objective of this research is to produce CAJ using various treatments such as pressure, salt, gelatine, carbonate, hot water and pasteurization methods, produce cashew kernel using oil frying and oven drying methods and to evaluate the effect of these treatments on the quality characteristics and tannin reduction on the both products.

MATERIALS AND METHODS

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Materials

A total of 30kg of mature, ripe cashew (*Anacardium occidentale L.*) apples, red and yellow varieties were harvested in an orchard at Uturu, Abia State, Nigeria. All chemicals used were of analytical grade.

Processing of Cashew Apple

Cashew apples were transported from the place of harvest to Food Science and Technology laboratory, Rivers State University of Science and Technology, Port Harcourt, Nigeria. Cashew apple juice was produced using the method reported by Emelike and Ebere (2015b). They were sorted to remove the rotten ones, deseeded, weighed and washed in running water. The apples were allowed to drain off water after washing. They were sliced and blended using Sumeet Food Processor (Model A). The blended apples were divided into seven portions of 2kg each.

Treatments of the blended cashew apples to obtain caj

The first portion was kept and used as the unpasteurized apple (UPA) which served as the control sample. The second portion was filled in 100ml sterile plastic bottles consecutively, loosely capped and pasteurized in a water bath at temperature of 80^{o}C for 15min to obtain pasteurized apple (PA). The next was wrapped in cellophane and steamed in pressure cooker for 5min at 10 – 15Lb pressure to stand as the pressure treated apple (PTA). Another portion was gelatine treated apple (GTA) which was treated with 100g of gelatine and was allowed to stand for 2h in a plastic basin. The fifth portion was carbonate treated apple (CTA) treated with 100g of sodium carbonate and allowed to stand for 6h in a plastic basin. Another portion was treated with 10g of salt and allowed to stand for 30min to obtain salt treated apple (STA). The last portion was wrapped in small batches of 200g and immersed in hot water temperature for 20min to obtain hot water treated apple (HWTA). All the blended treated and untreated cashew apples were then pressed to express the juice through muslin cloth folded into 2, 4 and 8 layers, respectively.

Processing of cashew kernel

Cashew kernels were processed using the previous method outlined by Emelike *et al.*, (2015a) for defatted and undefatted cashew kernel flour with some modifications. The nuts were sun dried for three days to prevent deterioration during storage. They were conditioned (mild spraying with water in a sieve) to increase flexibility and prevent scorching. The conditioned cashew nuts were divided into portions of 500g each for easy processing, placed in a metal basket and immersed in a pot of hot vegetable oil (Corn oil) for a min to make the shell brittle for shelling. The nuts were stirred at intervals of 10sec to prevent burning while in the hot oil. The cashew nut shell liquid (CNSL) of the nut extracted into the pot as the volume of the oil increases in the pot. The cashew nuts were poured out after a min and allowed to cool for about an hour. The brittle shell was broken with wooden mallet and the kernel extracted. The kernels were pulled together which yielded 13.14kg.

Oil frying and oven drying methods of the cashew kernel

The cashew kernel was oven dried at 60^{o}C for 2h and divided into two equal parts of 6.57kg. They were cooled at room temperature (28±2^{o}C) and the testa removed. One portion was then flash fried in vegetable oil (Corn oil), cooled again, sorted and packaged to get the oil fried cashew kernel sample. The other was oven dried again at 110^{o}C for an hour. It was allowed to

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cool, sorted and packaged. The various treatments applied in this study were methods used to reduce tannin in cashew apple juice (CAJ) and the kernel in order to render them more palatable (CTRI, 1988; Ohler, 1988).

Physical Properties

pH

The pH of the treated and untreated cashew apple juice samples was determined using a digital pH meter (model PHs-2f, USA). The pH meter was calibrated using buffer solutions of pH 4.0 and 7.0. Ten (10ml) of each juice samples was measured into a 10ml beaker. The electrode of the pH was placed into each juice sample and the pH was read on the LCD screen after sufficient time was allowed for stabilization.

Colour

The colour of the treated and untreated cashew apple juice samples was determined using lovibond tintometer in accordance to European Brewery Convention (EBC) colour scale. A special kit Lovibond AF 300 on the Lovibond Comparator 2000^{+} for visual colour grading was used which ranges from 2 – 27. This was done by matching 25mm optical glass cell with the precalibrated colour glass filters.

Total Solid

The total solid content of the cashew apple juice samples was determined using the air oven method. Aluminium dishes were washed; dried in an oven for 10min and kept in the desiccator to cool, after which their weights were taken. Three grams (3g) of the juice samples were weighed into the dishes and weight of the dish plus samples were taken. The dishes were placed in the oven for an hour at 105^{o}C and were removed after cooling. The total of solid content was then calculated.

Titratable Acidity (TTA)

Ten (10ml) of the cashew apple juice samples was pipetted into a conical flask and 25ml of distilled water was added as described by AOAC (2012). Two hundred millimetres (200ml) of 0.1M NaOH was powered into a burette and was titrated against the sample in the flask using three drops of phenolphthalein as indicator. It was titrated until a pink colouration was observed and the corresponding burette reading was taken using the following formula.

$$\text{Titratable acidity (\%)} = \frac{\text{Titre x blank x normality of base x ml equivalent of citric acid}}{\text{Weight of sample}}$$

ML equivalent of citric acid (meq) = 0.06404

Chemical properties of cashew apple juice and the kernel

Moisture, crude protein, crude fibre, total ash, esther extract and tannin of treated and untreated cashew apple juice including the oil fried and oven dried cashew kernel were determined using the method outlined by AOAC (2012). Carbohydrate was determined using Clegg Anthrone method described by Osborne and Voogt (1978).

Sensory properties

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Sensory evaluation was conducted on the various cashew apple juice and the cashew kernel samples using a twenty member panelist consisting of staff and students of Food Science and Technology Department, Rivers State University of Science and Technology, Port Harcourt, Nigeria. Criteria for selection were that panelist were 18 years of age, regular consumers of cashew apple juice and the kernel and were neither sick nor allergic to any juice and kernel. Panelists were trained in the use of sensory evaluation procedures. At each session, samples were served on white disposable cups and plates, consecutively and properly coded with 3-digit random numbers to prevent bias. Colour, taste, flavour, attractiveness, desirability, astringency and general acceptability were the organoleptic qualities evaluated. A descriptive five point hedonic scale as described by Iwe (2010) with some modifications, 1 and 5 representing the least score (dislike extremely) and the highest score (like extremely), respectively were used to score the treated and untreated cashew apple juice as well as the oil fried and oven dried cashew kernel for the characteristics mentioned above. Necessary precautions were taken to prevent carryover flavour during the tasting by ensuring that panelists rinse their mouth with water after each session of sensory evaluation.

Statistical Analysis

Results were expressed as mean values and standard deviation of five (5) determinations. Data were analyzed using a one-way Analysis of Variance (ANOVA) with the aid of Statistical Package for Social Science (SPSS) version 20.0 software 2011 to test the level of significance ($p<0.05$). Duncan New Multiple Range Test was used to separate the means where significant differences existed according to the method stated by Wahua (1999).

RESULTS AND DISCUSSION

Physicochemical properties and tannin content of CAJ

Effect of treatment on the physicochemical properties of cashew apple juice (CAJ) showed that carbonated treated apple (CTA) juice sample had significantly higher ($p<0.05$) pH value of 7.28 as against the range of 4.06 – 4.22 for HWTA and GTA juice samples, respectively, as presented in Table 1. Carbonate must have caused the pH value of the juice to increase towards alkalinity. Cashew apple is an acidic fruit and this is evident in the report of Emelike and Ebere (2015b) for untreated cashew apple juice with a pH value of 4.1. Significantly higher and lower colour of 7.50EBC and 3.08EBC was observed on the GTA and CTA juice, respectively. Gelatine might have reacted with tannin under heat to form coloured complexes because tannins are said to hydrolyse proteins (Osagie *et al.,* 1996) while carbonate might have bleached the colour off the CTA juice. Emelike and Ebere (2015a) reported untreated cashew apple juice with a natural colour of 5.1EBC. There was an increase in the total solid of all the treated juice samples compared to the untreated (UPA juice) with a value of 13.60% except PA juice sample with significantly lower total solid of 12.76%. It was evident that heat treatment increased total solid as a result of moisture removal. STA juice sample had significantly highest ($p<0.05$) titratable acidity value of 1.97% while CTA had the lowest value of 0.03%. This is in close agreement with the range of 0.56 – 0.7.0% reported by Adou *et al.,* (2012) for cashew apple juice. A correlation was observed between pH value and titratable acidity. At the highest pH value, a lowest titratable acidity was recorded while low pH leads to high titratable acidity. This is in agreement with the report of Ndife *et al.,* (2013) who observed a reduced pH leading to an increased acidity value of different brands of orange juice. GTA juice sample had

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significantly highest protein (8.52%) compared to other juice samples. Gelatine could be high in crude protein which imparted on the juice during treatment. The protein levels of other treated juice samples were low with a range of 0.22% for STA and HWTA to 0.46% for CTA as would be expected in fruit juices. This protein value is within the range of 0.03 – 0.53% reported by Banigo *et al.,* (2015) for soy/carrot/beetroot drink. Emelike *et al.,* (2015b) reported a value of 0.1 – 0.2% for beetroot juice and stated that fruit juices are not good sources of protein. Significantly highest ash (3.72%) and lowest carbohydrate (6.81%) was observed in CTA juice sample while STA recorded the lowest ash value of 0.24% and highest carbohydrate of 8.62% compared to other juice samples. Tannin was observed to be higher ($p<0.05$) in UPA juice sample (2.84mg/100ml) and lowest value of 0.07mg/100ml in HWTA juice.

Hot water treatment (HWTA) effectively reduced the tannin content by 96.20%, followed by STA with 72.82%, PTA 54.34%, GTA 30.43% and the least was CTA with the value of 11.95% as presented in Figure 1. It is interesting to note that simple hot water treatment reduced the tannin considerably. This goes to show that the predominant tannin in cashew apple are hydrolysable tannins not condensed tannins that are insoluble. Hot water treatment is a simple inexpensive method that can be easily applied by the home-maker, literate or illiterate, rich or poor. Therefore, cashew apple juice can be locally processed by dipping the apples in hot water to eliminate the anti-nutrient known as tannin present in it before expressing the juice, thereby reducing the wastage or exportation of cashew apples in Nigeria.

Table 1: Effect of Treatments on the Physicochemical Properties and Tannin Content of CAJ

Samples	pH	Colour (EBC)	Total Solid (%)	Titratable Acidity (%)	Crude Protein (%)	Ash (%)	CHO (%)	Tannin mg/100 ml
UPA	4.13±0.34^{b}	5.13±0.45^{c}	13.60±0.09^{e}	0.29±0.01^{b}	0.37±0.01^{b}	0.51±0.02^{b}	7.81±0.02^{b}	2.84±0.01^{a}
PA	4.10±0.02^{b}	5.83±0.09^{b}	12.76±0.20^{f}	0.27±0.02^{b}	0.29±0.01^{b}	0.50±0.01^{b}	7.81±0.08^{b}	2.10±0.02^{b}
PTA	4.10±0.08^{b}	5.10±0.08^{c}	16.79±0.03^{c}	0.37±0.01^{b}	0.34±0.02^{b}	0.27±0.01^{c}	7.55±0.02^{b}	0.84±0.01^{d}
GTA	4.22±0.09^{b}	7.50±0.63^{a}	24.83±0.09^{a}	0.42±0.01^{b}	8.52±0.07^{a}	0.34±6.02^{c}	6.17±0.03^{c}	1.28±0.04^{c}
CTA	7.28±0.01^{a}	3.08±0.45^{d}	15.15±0.04^{d}	0.03±0.01^{c}	0.46±0.02^{b}	3.72±6.04^{a}	6.81±0.02^{c}	1.62±0.08^{c}
STA	4.08±0.02^{b}	5.72±0.09^{b}	18.09±0.08^{b}	1.97±0.01^{a}	0.22±0.01^{b}	0.24±0.01^{c}	8.62±0.05^{a}	0.50±0.01^{e}
HWTA	4.06±0.01^{b}	5.50±0.63^{b}	16.60±0.07^{c}	0.35±0.02^{b}	0.22±0.01^{b}	0.32±0.02^{c}	7.54±0.04^{b}	0.07±0.04^{f}

^{a,b,c,d,e,f} Means not followed by the same superscript differ significantly at 5% level of probability ($p<0.05$). ± = Standard deviation of five determinations.

Key: CHO = Carbohydrate, CAJ = Cashew apple juice, UPA = Unpasteurized CAJ, PA = Pasteurized CAJ, PTA = Pressure treated CAJ, GTA = Gelatine treated CAJ, CTA = Carbonate treated CAJ, STA = Salt treated CAJ, HWTA = Hot water treated CAJ

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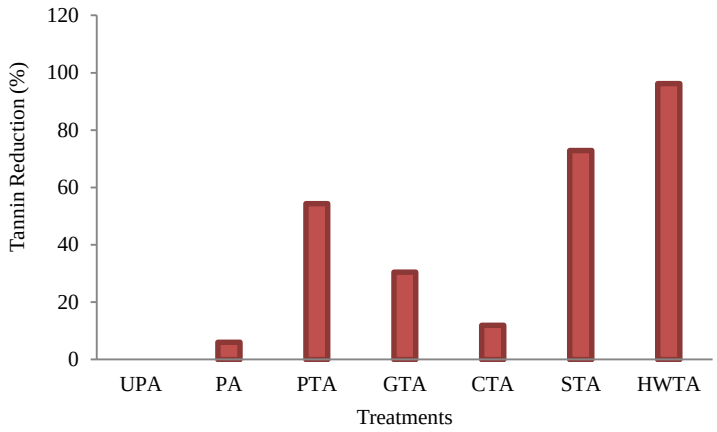

Figure 1: Tannin Reduction of Treatment Cashew Apple Juice (CAJ) samples

Key: UPA = Unpasteurized CAJ, PA = Pasteurized CAJ, PTA = Pressure treated CAJ, GTA = Gelatine treated CAJ, CTA = Carbonate treated CAJ, STA = Salt treated CAJ, HWTA = Hot water treated CAJ

Sensory evaluation of treated cashew apple juice

Sensory evaluation of various treated and untreated cashew apple juice (CAJ) showed that the colour of STA and HWTA juices compared favourably with the UPA juice sample with the values of 4.59, 4.65 and 4.67, respectively, as presented in Table 2. GTA (4.13), STA (4.02) and HWTA (4.21) treated juice samples were observed to have a significantly higher taste while CTA (2.93) with lower taste score compared to other juice samples. Apart from CTA (2.86) with significantly lower flavour, the flavour of other treated juice samples compared well with the control juice sample (UPA). PA, STA and HWTA had higher desirability mean scores of 4.13, 4.07 and 4.27, respectively than UPA juice sample (3.60). The astringency score of the juice recorded significantly higher in UPA (4.80), PA (4.67) and CTA (4.20) while GTA and HWTA was effective in reducing the astringency of the juice samples (2.92 and 2.53), respectively. GTA (4.60) and HWTA (4.93) had a significantly higher general acceptability while CTA had significantly lower score of 2.47 on a 5 – point hedonic scale compare to other juice samples. In general, HWTA juice sample was observed to maintain a higher similar likeness in all the sensory attributes studied and was effective in reducing the astringency of the cashew apple juice which has been a limiting factor to its consumption.

Table 2: Effect of Treatments on the Sensory Evaluation of CAJ

Samples	Colour	Taste	Flavour	Desirability	Astringency	General Acceptability
UPA	4.67±0.50^{a}	3.67±0.01^{b}	3.47±0.72^{a}	3.60±1.02^{b}	4.80±0.72^{a}	3.07±0.99^{bc}

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PA	3.93±0.80[b]	3.87±0.88[b]	3.53±0.62[a]	4.13±0.72[a]	4.67±0.81[a]	3.40±0.80[b]
PTA	3.67±0.90[b]	3.06±1.06[c]	3.47±0.50[a]	3.53±0.96[b]	3.53±0.96[b]	3.53±0.96[b]
GTA	3.87±0.60[b]	4.13±0.72[a]	3.40±0.61[a]	2.93±0.06[c]	2.92±0.85[c]	4.60±0.61[a]
CTA	3.60±0.50[b]	2.93±1.42[d]	2.86±0.57[b]	2.73±0.85[c]	4.20±0.40[a]	2.47±0.72[c]
STA	4.59±0.50[a]	4.02±0.10[a]	3.33±0.70[a]	4.07±0.97[a]	3.40±0.80[b]	3.80±0.75[b]
HWTA	4.65±0.50[a]	4.21±0.98[a]	3.60±0.49[a]	4.27±0.85[a]	2.53±0.47[c]	4.73±0.44[a]
LSD	0.68	1.06	0.89	0.98	0.79	0.80

[a,b,c] Means not followed by the same superscript along the column differs significantly at 5% level of probability ($p<0.05$)

Key: CAJ = Cashew apple juice, UPA = Unpasteurized CAJ, PA = Pasteurized CAJ, PTA = Pressure treated CAJ, GTA = Gelatine treated CAJ, CTA = Carbonate treated CAJ, STA = Salt treated CAJ, HWTA = Hot water treated CAJ

Chemical properties and tannin reduction of oil fried and oven dried cashew kernel

Moisture content of the imported cashew kernel was not significantly different ($p<0.05$) from the oil fried and oven dried cashew kernels with the values of 4.7, 4.8 and 4.3%, respectively, as shown in Table 3. The temperature applied during processing must have been the same significantly with the one used in the imported kernel which leads to a non-significant moisture content. These values fall within the range of 4.4 – 5.7% for defatted and undefatted cashew kernel flour reported by Emelike *et al.,* (2015a). The percentage crude protein of the oil fried (21.1%) and oven dried (21.4%) cashew kernels were not significantly different ($p<0.05$) compared to the imported cashew kernel with the value of 21.0%. This is in agreement with the report of Emelike and Ebere (2015c) of a non-significant difference between sand and gari roasted cashew kernel to the control kernel sample. Vincent *et al.,* (2009) reported a slightly higher protein value of 27.31% for roasted and defatted cashew nut flour. This is because the protein content of the cashew kernel must have been made more assessable after oil (Cashew Nut Shell Liquid) was extracted from the kernel. Crude fibre of the imported kernel (1.6%) did not differ significantly with those processed from oil fried (1.3%) and oven dried (1.1%) method. These values agreed with the fibre content of 1.2% and 1.425% for cashew nut flour and roasted/defatted cashew nut flour, respectively reported by Aremu *et al.,* (2006); Vincent *et al.,* (2009). Total ash, esther extract and carbohydrate values of the oil fried and oven dried cashew kernel compared favourably to the imported kernel with no significant difference. Emelike and Ebere (2015c) equally reported no significant difference between sand, gari and the control cashew kernel in these three chemical components. The processing methods had a marked effect on the tannin content of the kernels with no significant difference ($p<0.05$) between the oil fried (0.1%) and the imported cashew kernel (0.1%) while oven dried kernel had significantly higher tannin with the value of 0.4%. It could be deduced that oil frying reduced the tannin content of the kernel remarkably. Emelike and Ebere (2015c) reported cashew kernel produced with gari roasting method to be more effective in reducing the tannin content of the kernel compared to the control cashew kernel. This is due to the fact that the tannin might have been dissolved into the oil and moisture in gari under heat. The findings thus

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reinforced the fact that flash oil frying and gari roasting are the best local methods to adopt in the production of cashew kernel for consumption.

Table 3: Chemical Properties of Oil Fried and Oven Dried Cashew Kernel and Tannin Reduction

Parameters (%)	Oil Fried	Oven Dried	Imported
Moisture	4.8±0.02[a]	4.3±0.03[a]	4.7±0.10[a]
Crude Protein	21.1±0.01[a]	21.4±0.40[a]	21.0±0.20[a]
Crude Fibre	1.3±0.05[a]	1.1±0.05[a]	1.6±0.20[a]
Total Ash	4.9±0.02[a]	4.6±0.10[a]	5.0±0.01[a]
Ether Extract	50.6±0.10[a]	49.1±0.20[a]	48.4±0.10[a]
Carbohydrate	19.9±0.04[a]	20.1±0.09[a]	20.1±0.02[a]
Tannin	0.1±0.12[b]	0.4±0.04[a]	0.1±0.01[b]

[a,b] Means not followed by the same superscript within the rows differs significantly ($p<0.05$)

± = Standard deviation of five determinations.

Sensory properties of oil fried and oven dried cashew kernel

Analysis of the sensory properties of the oil fried, oven dried and imported cashew kernel showed colour values of 4.60, 1.50 and 4.70 respectively, with no significant difference ($p<0.05$) between oil fried and the imported kernels as presented in Table 4. Emelike and Ebere (2015c) also reported no significant effect in colour of the gari roasted and the control cashew kernel sample. A significantly lower ($p>0.05$) scores was recorded in all the sensory attributes of cashew kernel processed with oven dried technique. Oil fried cashew kernels was observed to maintain the sensory attributes of taste, flavour, attractiveness and general acceptability (4.70, 4.20, 4.90 and 4.90, respectively) compared to the imported cashew kernels with no significant difference. A slight difference was reported by Emelike and Ebere (2015c) who observe a significantly lower taste and attractiveness while significant difference was not recorded in flavour and general acceptability of the gari roasted and the control kernel samples, respectively. This is an evident that cashew kernels processed using oil frying technique was able to maintain all the sensory attributes more than oven drying technique compared to the imported kernels. Aroyeun (2009) produced biscuit with cashew kernel meal and reported no significant effect in the organoleptic attributes of colour, taste, texture and general acceptability of the product compared to the control sample. Ebere *et al.*, (2015) equally reported that cookies produced with 20% cashew apple residue substitution maintained same sensory attributes with cookies produced from 100% wheat flour. These reports are evident that cashew kernel and residue can be dried, milled and used as a raw material in the production of snack products and still retain its sensory attributes as those produced from 100% wheat flour. Dried and milled cashew products have an advantage over chapattis produced from flaxseed flour which affected significantly all its organoleptic properties reported by Hussain *et al.*, (2008). Emelike and Ebere (2015c) reported sensory characteristics of sand and gari roasted cashew kernel and stated that gari roasting method can be adopted as the best method in the processing of cashew kernel. Comparing the sensory attributes of oil fried and oven dried cashew kernel in this study, it can be concluded that oil frying have advantage over oven drying technique and can be employed in the processing of cashew kernel locally as an alternative measure to reduce the wastage and exportation of the Nigerian grown cashew kernels.

Table 4: Sensory Properties of Oil Fried and Oven Dried Cashew Kernel

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Parameters	Oil Fried	Oven Dried	Imported	LSD
Colour	4.60[a]	1.50[b]	4.70[a]	0.50
Taste	4.70[a]	2.80[b]	4.50[a]	0.77
Flavour	4.20[a]	3.80[b]	4.50[a]	0.41
Attractiveness	4.90[a]	1.50[b]	5.00[a]	0.35
General Acceptability	4.90[a]	2.80[b]	5.00[a]	0.28

[a,b] Means not followed by the same superscript differs significantly at 5% level of probability ($p<0.05$).

CONCLUSION

The analysis showed that hot water treatment was effective in reducing the tannin content of the cashew apple juice (CAJ) by 96.20%. All the sensory attributes of HWTA juice was equally observed to maintain a significantly high ($p<0.05$) scores and active in reducing the astringency of the treated juice compared to other juice samples. There was no significant difference in all the chemical properties of cashew kernel processed with oil frying and oven drying techniques compared to the imported kernel. Oil frying technique was observed to reduce the tannin content of the cashew kernel as compared to the imported kernel by 1% each. All the sensory attributes of the oil fried cashew kernel compared favourably with the imported kernels.

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