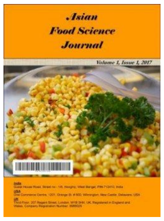

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Production and Quality Evaluation of Fruit Bars from Banana (*Musa sapientum*) and Cashew (*Anacardium occidentale*) Apple Fruit Blends

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Authors' contributions

This work was carried out in collaboration between both authors. Author CSA designed the study, performed the statistical analysis, managed the analyses of the study, wrote the protocol and wrote the first draft of the manuscript. Author IN managed some of the literature searches and supervised the work. Both authors read and approved the final manuscript.

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ABSTRACT

Aim: The aim was to evaluate the chemical, physical, sensory and microbial qualities of fruit bars produced from blends of banana and cashew apple fruits and to investigate the applicability of cashew apple in fruit bar production.
Study Design: The experimental design used was the complete randomized design (CRD) and the data obtained were analyzed using one – way analysis of variance (ANOVA).
Place and duration of Study: The study took place at the Department of Food Science and Technology, University of Nigeria, Nsukka between January and July, 2016.
Methodology: Fruit bar samples were prepared with blends of ripe banana and cashew apple purees in the ratios of 90:10, 80:20, 70:30, 60:40, 50: 50% (Banana puree : Cashew apple puree). One hundred percent (100%) banana pulp based fruit bar served as the control. Formulated fruit bars contained 7% sugar, 5% date powder, 0.2% sodium metabisulphite and 0.5% citric acid in 1000 g of fruit purees and dried at 80°C for 8 hours. Fruit bar samples were analysed for sensory

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qualities, proximate composition, micronutrient compositions (vitamin C and potassium), physicochemical properties (pH, brix and titratable acidiy), and microbiological quality using standard methods.

Results: There were significant ($p<0.05$) differences in the proximate composition, potassium, vitamin C and tannin content of samples. The carbohydrate, protein, crude fibre, ash and moisture contents ranged from 68.78 to 74.51%, 3.06 to 3.38%, 1.00 to 2.05%, 2.33 to 2.76% and 18.92 to 22.64% respectively. The fruit bars have high caloric energy values. The vitamin C content increased as the ratio of cashew apple increased. Potassium and tannin contents of the samples ranged from 125.50 to 220.00mg/100g and 52.04 to 84.23 mg/100g respectively. Titratable acidity, pH and brix of samples varied significantly ($p < 0.05$) and ranged from 0.23 to 0.37%, 4.00 to 4.65% and 7.10 to 11.85% respectively. The microbial results showed that total viable count found present in the fruit bar samples ranged from 4.0×10^2 to 1.3×10^3 while the mould count ranged from 2.0×10^1 to 7.0×10^1. The sensory scores showed that all samples were generally accepted while the sample with 20% of cashew apple was the most preferred. These results showed that underutilized fruits such as cashew apple can be utilized in this regard instead of being wasted.

Keywords: Fruit bar; fruits; banana; cashew apple; fruit puree.

1. INTRODUCTION

Fruits are the developed ovaries of flowers or the fleshy seed bearing parts of plants. Commercially and with regards to the food science and technology perspective, fruits are plant parts which have succulent, aromatic and fragrant characteristics and derived from the botanical fruits. Thus in food science, not all botanical fruits are regarded as fruit [1]. Fruits are processed into various shelf stable products and concentrates like juices, jams, squashes and smoothie. Fruits are also processed into dehydrated forms like fruit bars and fruit leathers/sheets; this is one of the new technologies adopted to preserve fruits [2]. Fruit processing involves indispensable steps to achieve best quality products with longer shelf life, wholesome and sensory acceptable products at affordable prices. Processing of fruits is intended to do two things; firstly, to preserve fruits by slowing down the natural processes of decay caused by microorganisms, enzymes in the fruit, and/or other factors such as heat, moisture and sunlight. Secondly, to change fruits into different foods, which could be more attractive and in demand by consumers [3].

Fruit bars also known as fruit leather or fruit roll are dried bars/sheets of fruit pulp that have soft, rubbery texture and sweet taste [4]. Fruit leathers/bars are restructured fruit made from fresh fruit pulp or a mixture of fruit juice concentrates and other ingredients after a complex operation that involves a dehydration step [5,6]. It is classified as a confectionary product with longer shelf life and is considered to be hygienic as it is produced mechanically. They are attractively packed and consumed readily. Fruit bar is a dehydrated fruit-based confectionery dietary product which is often eaten as snack or dessert [7]. It is chewy and flavourful, naturally low in fat and high in fibre and carbohydrates; it is also of light weight and easily stored and packed [8]. Basically, fruit pulps are mixed with appropriate quantities of sugar, pectin, acids (citric acid, ascorbic acids among others), and colour and then dried into sheet-shaped products. Many fruits are suitable for fruit leather, including apples, apricots, bananas, berries, cherries, grapes, oranges, pears, pineapples, plums, strawberries, tangerines, and tomatoes. Fruit combinations make a variety of flavours possible and this provides a nutritious treat for both the young and old [7]. Consuming fruit leather is an economic and convenient value-added substitute for natural fruits as a source of various nutritional elements. Fruit pulp-based fruit leathers are nutritious and organoleptically acceptable to customers [5]. They contain substantial quantities of dietary fibres, carbohydrates, minerals, vitamins, and antioxidants [8,9]. Most fresh fruits have short harvest season and are sensitive to deterioration even when stored under refrigerated conditions. Therefore, making fruit leather from fresh fruits is an effective way to preserve fruits [6]. The preservation of fruit leather depends on their moisture content (15 – 25%), the natural acidity of the fruit and high sugar content [10].

Banana (*Musa sapientum*), are elliptically shaped fruits ‘prepacked’ by nature, featuring a creamy firm flesh, wrapped inside a thick inedible peal. It is found available throughout the year. Banana is a very good source of vitamin B_6 (pyridoxine), manganese, vitamin C (ascorbic acid) a powerful natural antioxidant, potassium, dietary fibre, biotin and copper [11]. Banana pulp is composed of soft, easily digestible flesh with simple sugars like fructose and sucrose that when eaten replenishes energy and revitalizes the body instantly [12]. Therefore, pulpy fruits like banana with good amount of sugar are best suited for making fruit bars.

Cashew is a species of fruit that produces cashew nut (true fruit) and cashew apple (false fruit) [13]. Cashew apple is rich in sugar, riboflavin, vitamin C, iron, minerals and organic acids [14,15,16]. The vitamin C content of cashew apple fruit is ten times more than that of pine apple and five times more than that of orange [17]. It has been rated as one of the leading indigenous fruits seen in local markets during harvest seasons in countries of South America and Africa [18]. In all its nutritional benefits, cashew apple fruit (*Anacardium occidentale*) is an underutilized fruit in the food industries due to its high perishable and susceptibility to spoilage. Recently, few studies have been conducted to develop new cashew products and to make a better use of cashew apples. Some of those products are cashew wine from cashew apple juice [19], bioethanol from cashew apple juice [20], cashew apple flavoured yoghurt [21] and utilization of cashew apple fibre in the production of hamburger as a partial substitute of cow meat [22]. Also juices, fenny, wine, dried cashew apple, syrup and jam have been produced from cashew apple fruits [23] However, there is limited study on the use of cashew apple fruits in the production of fruit bar or mixed fruit bar.

Also, fresh fruits like cashew fruits have short harvest season and are not available throughout the year [24]. Little industrial value is attached to cashew apple fruits in Nigeria and Africa. The level of consumption and utilization of cashew apple fruit in the food industries are low, lower than cashew nut utilization and consumption. According to Morton [25], cashew fruits (pseudo fruits or false fruits) are said to be by-products of the cashew nut industry. However, there is need to find a wider use of cashew apple fruits. More so, according to Talasila and Khasim [26], high perishability, astringency and short shelf life prevent the effective utilization of cashew apples; due to high content of tannin, which when consumed increases the risk of low protein assimilation [25]. Therefore, in cashew apple processing into functional foods and products, tannins are reduced to tolerable and acceptable level that would be safe for human consumption.

In the production of fruit bars, optional ingredients such as sweeteners, preservatives, stabilizers, toppings and nutrients are used in the production of fruit bar are. Date palm, coconut and slivered almonds are used as toppings in production of fruit bar. They are added before the fruit puree is dried to improve the consistency of the puree and enhance easy drying.

Consumption of fruits is very important as they are nutritious and good sources of vitamins and minerals although the most prevalent problems associated with fresh fruits are their sensitivity to deterioration, post harvest losses and short harvest seasons. During the process of harvesting and distribution, substantial losses are incurred, which range from a slight loss of quality to total spoilage [27]. Losses sometimes could be due to surplus supply of fruits in the market place in its seasons and with fewer consumers to buy [27]. This is seen in the case of both cashew and banana fruits.

In order to preserve these fruits (such as banana and cashew), avoid subsequent losses and make the fruits available throughout the year; fruits are processed and preserved industrially into various products of which production of fruit bars is one of such method. Fruit bars are consumed conveniently than whole fruits and presents a whole lot of nutrient. This is because two or even more fruits could be concentrated in one bar. Since cashew apple fruits are highly perishable and susceptible to spoilage, its use in formulating fruit bars with banana would add value, create varieties, improve organoleptic properties of the final product and create a stable market for farmers and food processors, thereby improving the utilization of cashew apple and economy of the country. Heat treating (pressure steaming of cashew apple fruit), drying and addition of food preservatives (citric acid, sodium benzoate and benzoic acid) could extend the shelf life of a banana and cashew apple based product [28, 25].

Therefore the broad objective of this study was to produce and evaluate the qualities of fruit bars from blends of banana (*Musa sapientum*) and cashew apple fruits (*Anacardium occidentale*) as well as to evaluate the microbiological quality and sensory characteristics of the formulated fruit bars.

2. MATERIALS AND METHODS

2.1 Materials

Cashew fruits, banana fruits, sugar, citric acid and glycerine were purchased from Ogige main market in Nsukka, Nsukka Local Government Area, Enugu state, Nigeria. Dates (*Phoenix dactylifera*) were purchased from central market Birnin Kebbi, Kebbi state, Nigeria. Sodium metabisulphite was gotten from the Food Science and Technology Departmental Laboratory, University of Nigeria Nsukka, Enugu state. Some of the equipment used include blender, oven drier, trays, stainless steel knife, small sized bowls and glass jar for packaging of the products.

2.2 Preliminary Studies

Preliminary studies were carried out to:

i. Determine the best method that was used to produce the fruit bars from banana and cashew apple fruits by modifying the processes described by [10] thereby arriving at the procedures shown in Fig. 1.
ii. Determine the best blends and formulations of the fruits (banana and cashew apple fruit pulp) that were used to produce the fruit bars used for this research work.
iii. Determine the best temperature range and time required to dry the fruit puree in order to retain an acceptable colour of the fruit bars.
iv. Determine the appropriate quantity of fruit puree that was poured in a 25 x 25 cm aluminium tray.

The raw materials used for the formulation of the fruit bars were banana and cashew apple fruits, sugar as sweetener, ground date powder as toppings and sweetener, citric acid as preservative and sodium metabisulphite as preservative and anti-browning agent. Table 1 shows the proportions of banana and cashew apple fruit purees used for fruit bars while Table 2 shows the proportions of the ingredients added in 1000 g of banana-cashew apple fruit purees.

2.3 Production of Banana-cashew Apple Fruit Bar

The ripe cashew fruits and banana were sorted to remove the spoilt or damaged fruits and then washed in clean water to remove contaminants and dirt. The cashew fruits were deseeded to remove the attached seeds and the banana fruits were peeled. The fruit pulp (cashew and banana) were sliced separately into thin pieces with clean stainless steel knife and then blended separately in a blender (Masterchef blender, MC–BL3302) to obtain smooth purees. The fruit purees were weighed to obtain the appropriate proportion needed for each blend so as to obtain a total of 1000 g for each sample. Six fruit bar samples were prepared with blends of banana and cashew apple purees in the ratios of 100: 0, 90:10, 80:20, 70:30, 60:40, 50: 50% (Banana puree : Cashew apple puree). Sugar (70 g), ground dates powder (50 g), citric acid (5 g) and sodium meta-bisulphite (2 g) were added into 1000 g of each sample puree and mixed thoroughly. The mixed purees were heated to 95°C for 5 minutes to concentrate the mixture, inactivate enzymes and inhibit microbial actions. The purees were poured into 25 x 25 cm aluminium trays covered with aluminium foil that were smeared with glycerine which aided the easy peeling off of the fruit leather after drying. The fruit purees were then oven dried at 90°C for 9 hours. The dried fruit bars were manually cut into equal shapes and packaged in airtight jars. The flow diagram for the production of banana-cashew fruit bars is shown in Fig. 1.

Table 1. Proportions of the fruit purees for the production of the fruit bar samples

Samples	Banana (*Musa sapientum*), (%)	Cashew fruit (*Anacardium occidentale*) (%)
B (100:0) (control)	100	0
BCA (90:10)	90	10
BCA (80:20)	80	20
BCA (70:30)	70	30
BCA (60:40)	60	40
BCA (50:50)	50	50

Key: B = Banana pulp; BCA = Banana and cashew apple pulp

Table 2. Proportions of the ingredients in 1000 g of fruit purees

Ingredient	Quantity (gram)	Percentage proportion (%)
Sugar	70	7.0
Ground date powder	50	5.0
Citric acid	5	0.5
Sodium metabisulphite	2	0.2

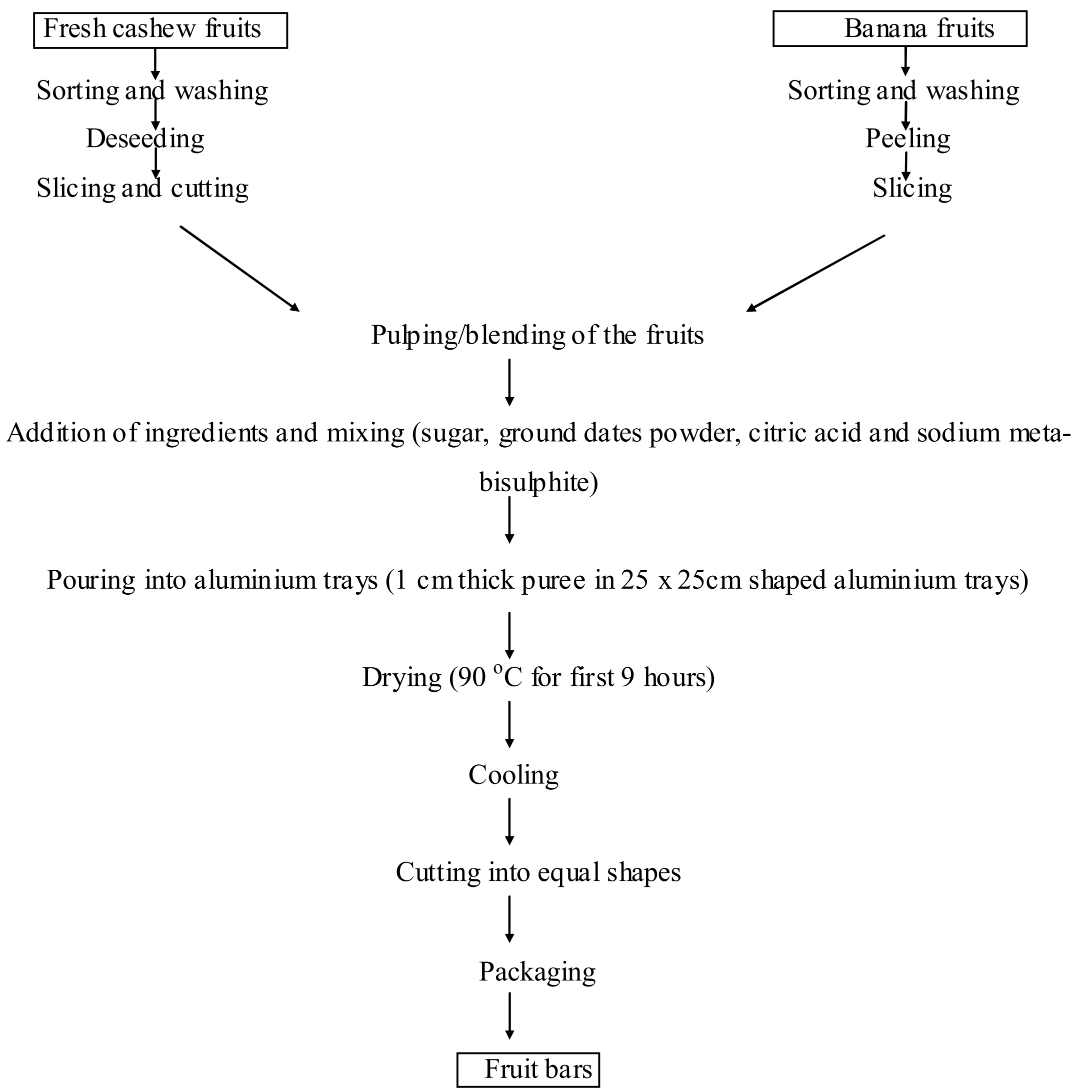

Fig. 1. Flow diagram for the production of banana-cashew fruit bars
Source: Modified from Food and Agricultural Organization (1997)

2.4 Analysis of Banana-cashew Fruit Bar Samples

The six fruit bar samples were analysed for proximate composition, physicochemical properties, micronutrient contents (vitamin C and Potassium), tannin content and sensory properties using standard procedures. The microbiological qualities of the samples were also analysed.

2.4.1 Proximate composition analysis

Determination of moisture content: The moisture content of the formulated fruit bar samples from blends of banana and cashew apple fruits were determined using the hot oven method of Association of Official Analytical Chemists [29].

Determination of crude protein content: The crude protein content (percentage nitrogen x 6.25) of the fruit bar samples were determined by the semi micro – Kjeldahl technique [29].

Determination of crude fat content: The solvent extraction method as described by Association of Official Analytical Chemists [29] was used for the determination of the crude fat content of the fruit bar samples. The method involves the use of soxhlet extraction apparatus with organic solvent petroleum ether.

Determination of crude fibre content: The crude fibre contents of the formulated fruit bar samples were determined using the method [29]. Two grams (2 g) of each of the samples were weighed into a 500 ml beaker each, 150 ml of preheated H_2SO_4 was added and were heated for 30 minutes, filtered under suction and then washed with hot distilled water until the washings were no longer acidic. The residues were transferred to another clean beaker and boiled with 150 ml of preheated 0.223 M potassium hydroxide. The boiled mixture was filtered and the residues obtained from the filtration were washed with hot water severally until it was no longer alkaline. The residues were put into labelled and weighed crucibles (W_1), dried in an oven (LABE – 1201) at 110ºC for 2 hours. They were then cooled in a desiccator after drying, weighed (W_2) and then ashed in a muffle furnace (LABE – 1210) at 550ºC for 4 hours, cooled in a desiccator and weighed thereafter to obtain W_3. The percentage crude fibre content of the samples was calculated as follows:

Percentage (%) crude fibre = (W_2 – W_3 / Weight of original sample)

Determination of ash content: The ash content of the fruit bar samples were determined by the method [29]. Two grams of the samples were placed in weighed crucible (W_1) and weighed again with the sample as W_2. The crucibles containing the samples were transferred to the muffle furnace and heated to 550ºC for 4 hours in the furnace. At the end, the furnace was put off and allowed to cool. The crucibles were cooled in a desiccator and then weighed as W_3. The percentage ash content was then calculated using the expression;

Percentage (%) ash content = (W_2 – W_3 / W_2 – W_1) X 100

Determination of carbohydrate content: The carbohydrate content of the formulated fruit bar samples were determined as the nitrogen – free extraction calculated by differences as described by [29]. This was done by subtracting the sum of protein, crude fat, moisture, crude fibre and ash from 100. Percentage (%) carbohydrate = 100 – (protein + crude fat + moisture + crude fibre + ash) %.

Determination of energy value: The energy value of the fruit bars were calculated using the protein, fat and carbohydrate contents according to the method described by AOAC [29].

2.4.2 Physicochemical analysis

Determination of pH: The pHof the fruit bar samples were determined using a pH meter [29]. The electrode was dipped in an already weighed 10 ml of the sample solution. The pH of the sample was displayed on the screen and the reading was taken.

Determination of brix: The brix level of the fruit bar samples were determined using digital hand refractometer. Five grams of fruit bar samples were dissolved in 15 ml of warm distilled water and mixed properly. A disposable pipette was dipped into the solution and a drop of the solution was released into the silver plate of the refractometer to touch the prism. The enter button was pressed and the value was displayed on the screen.

Determination of titratable acidity*:* The titratable acidity of the fruit bar samples were determined by the method described by [29]. One gram of the samples were diluted in 10 ml of distilled water and titrated with standardized 0.1 M sodium hydroxide (NaOH) using 0.3 ml of phenolphthalein indicator. Titration was repeated until there was a change in colour to a pink end point. The titration was repeated to an average result.

Percentage (%) titrable acidity = (M (NaOH) x 0.09 / Volume of sample solution) x 100

2.4.3 Anti-nutrient analysis

The anti-nutrient of importance in the products was tannin. Tannin is responsible for the astringency of cashew apple and its puckery sensation in the mouth when eaten [30]. According to Morton [25] high content of tannin increases the risk of low protein assimilation. Therefore, the tannin contents of the fruit bars were determined.

Determination of tannin content: Tannin content was determined using the method described by Onwuka [31]. Two grams of each sample was dispersed in 10 ml of distilled water, agitated and left to stand for 30 minutes at room temperature. The mixtures were centrifuged and 2.5 of the supernatants were dispensed into six 50 ml volumetric flasks. Standard tannin acid solution (2.5 ml) was added into the six 50 ml volumetric flasks. One ml of Follin-dennis reagent was added into each flask, followed by 2.5 ml of saturated Na_2CO_3, diluted into 50 ml flask and incubated for 90 minutes at room temperature. The absorbance of each sample, standard and blank reagent were measured in an electronic spectrophotometer at 250 nm. Readings were taken with the regent blank at zero. The tannin contents were calculated as expressed:

$$\text{Percentage tannin} = \frac{A_n \times C \times 100 \times 5}{A_s \times W}$$

where A_n = Absorbance of test sample; As = absorbance of standard solution; W = weight of the sample and C = concentration of standard solution.

2.4.4 Micronutrient analysis

The micronutrient analysis carried out on the fruit bar samples were vitamin C (Ascorbic acid) and potassium (K).

Determination of vitamin C: The vitamin C content of the formulated fruit bar samples were determined using the method described by Osborne and Voogt [32]. Two grams (2 g) of the samples were diluted with 100 ml of distilled water and filtered to get clear solutions. The clear solutions were pipetted into small flasks and 2.5 ml acetone added. The mixtures were then titrated with indophenol solution (2, 6 – dichlorophenolindophenol) to a faint pink colour which persists for 15 seconds, the vitamin C contents were calculated as follows.

$$\text{Vitamin c (mg/100 g) of sample} = 20 \times V \times C$$

where: V = indophenol solutions in titration (ml); C = mg vitamin

Determination of potassium content: Potassium content of the samples was determined by the method described by Pearson [33]. Five grams (5g) of the samples were ashed and the ashes were transferred to 500 ml beaker and dissolved with 100 ml of distilled water. Then, 10 ml volumes of concentrated hydrochloric acid were added and the mixtures were boiled for several minutes, cooled and diluted with water to 500 ml, and filtered. The solutions were further diluted to a final concentration of approximately 15 mg/L potassium oxide (K_2O). Freshly prepared standard potassium solution containing 10, 12, 14, 16, 18 and 20 mg/L (K_2O) were also prepared. Absorbance readings were taken with atomic spectrophotometer, with a hollow cathode lamp of current (5 mA), slit width (0.7 nm) and wavelength of 7.65 nm.

2.4.5 Microbial analysis

Determination of total viable count (TVC): The total viable count was determined according to the method of [34]. The samples were inoculated using nutrient agar after the serial dilution of the samples had been obtained with 1 g of each sample. Pour plate method was used. The colony count was done after 24 hours of incubation at 37°C using a colony counter and the number of colonies calculated using the following method.

TVC (CFU / g) = (Number of colonies x Original concentration) / (Dilution factor x volume of inoculums). CFU = Colony Forming Unit

Determination of mould count (MC): The mould count was determined using the method described by Prescott et al. [34]. After the serial dilution of the samples, they were inoculated using Sabauroud Dextrose Agar (SDA). Pour plate method was used. The colony count was done after 72 hours on incubation at 37°C using a colony counter and the number of colonies calculated using the following method:

Mould count (CFU/g) = (Number of colonies x Original Concentration) / Dilution factor x Volume of inoculums). CFU = Colony Forming Unit.

2.4.6 Sensory evaluation

The sensory qualities (colour, taste, aroma, texture, mouthfeel, and aftertaste) and overall acceptability of the formulated fruit bar from banana and blends of banana and cashew apple fruit samples were evaluated by 20 semi-trained panellists consisting of staff and students of University of Nigeria Nsukka. The extent of differences between the samples for each sensory quality were measured on a nine – point Hedonic scale, where 9 represents extremely like and 1 represents extremely dislike according to Iwe [35].

2.4.7 Data analysis and experimental design

The experimental design used was the complete randomized design (CRD) and the data obtained from the analyses were analyzed using one – way analysis of variance (ANOVA). Also means were separated by Ducan's multiple range test method and the level of significance was accepted at ($p < 0.05$) according to Steel and Torrie [36].

3. RESULTS AND DISCUSSION

Plate 1 show the processed fruit bars from banana and cashew apple fruits.

Table 3 shows the proximate composition of the fruit bars from blends of banana and cashew apple fruits. The moisture content of the fruit bar samples ranged from 18.92 to 22.64%. There were no significant ($p > 0.05$) differences between samples B (100:0) and BCA (90:10), and samples BCA (60:40) and BCA (50:50). It is evident from the result that there was a gradual increase in the moisture content of the fruit bars as the concentration of cashew apple pulp increased. This could be due to the high content of cashew apple. These results correlated with the findings of Rehman et al. [37] that observed gradual increase in moisture (17.14 – 19.21%) with increasing concentration of Apricot paste.

The crude fibre content of the fruit bars ranged from 1.00% in sample B (100:0) to 2.05% in sample BCA (50:50). No significant ($p > 0.05$) difference existed between samples B (100:0) and BCA (90:10), and samples BCA (60:40) and BCA (50:50). The result showed that the fibre content of the fruit bars increased with the increase in the concentration of cashew apple pulp. This increase could be attributed to the high dietary fibre of cashew apple fruits. According to Rufino et al. [38] and Pinho et al. [22] cashew apples are high and rich in dietary fibre and low in fat.

The ash content of the fruit bars ranged from 2.33 % in sample B (100:0) to 2.76% in sample BCA (50:50). There were no significant ($p > 0.05$) differences between samples B (100:0), BCA (90:10), BCA (80:20), BCA (70:30) and BCA (50:50). It was observed that the ash content of the samples increased significantly ($p < 0.05$) with increase in concentration of cashew apple pulp. The ash content is a measure or quantity of minerals present in a food. According to Marc et al. [39] cashew apples are rich in mineral. The crude protein content of the fruit bars ranged from 3.06% in sample BCA (90:10) to 3.38% in sample BCA (60:40). There were significant ($p < 0.05$) differences in the crude protein content of the formulated fruit bar samples.

The crude fat content of the fruit bar samples ranged from 0.10% in samples B (100:0) and BCA (80:20) to 0.24% in sample BCA (60:40). No significant ($p > 0.05$) difference existed between samples with 10, 30, 40 and 50 percent of cashew apple pulp. The fat content of the fruit bar samples were generally low. This could be attributed to the low fat content of the fruits used for the formulation. According to Rufino et al. [38] cashew apples have low fat content. Thus, the banana-cashew fruit bars could be referred to as non-fatty food as this could be an advantage for its storage.

The carbohydrate content of the fruit bars decreased significantly ($p > 0.05$) with increase in the concentration of cashew apple pulp although there were no significant ($p > 0.05$) differences between samples B (100:0) and BCA (90:10), and samples BCA (60:40) and BCA (50:50). The fruit bars have high caloric energy value ranging from 291.36 to 311.42 Kcal/100g and thus could compliment daily requirement of consumers.

3.1 Physicochemical Properties of the Banana-cashew Fruit Bar Samples

Table 4 shows the pH, brix level and tiratable acidity of the fruit bar samples. The pH of the fruit bars ranged from 4.00 in sample BCA (50:50) to 4.65 in sample B (100:10). There was a gradual decrease in pH of the samples as the concentration of cashew apple pulp increased. This could be attributed to the acidity of cashew apple. Similar result was reported by Mbaeyi-Nwaoha and Iwezor-Godwin [21]. They reported that addition of cashew pulp in graded levels slightly lowered the pH of the flavoured yoghurt.

Plate 1. The banana-cashew apple fruit bar samples

There were significant ($p < 0.05$) differences in the titratable acidity of the samples; although no significant ($p > 0.05$) differences existed among samples B (100:0) and BCA (90:10); and sample BCA (80:20), BCA (70:30) and BCA (60:40). An increase in the concentration of cashew apple pulp caused an increase in the titratable acidity of the samples, while its increase led to decrease in pH of the samples.

Brix level of the fruit bars ranged from 7.10% in sample BCA (50:50) having the lowest brix level to 11.8 in sample B (100:0). The result showed that increase in the concentration of cashew apple pulp decreased the brix level of the samples, while the decrease in pH decreased the brix level.

The results obtained from the physicochemical properties of the fruit bar samples revealed the phenomenon between pH, titratable acidity and sweetness of a food or fruit. Consequently, it could be said that the pH is directly proportional to sweetness or brix level of the fruit bars and inversely proportional to the titratable acidity.

3.2 Anti-nutrient (Tannin) Composition of the Banana-Cashew Apple Fruit Bar Samples

Table 5 shows the tannin content of the fruit bars. The tannin content of the fruit bar samples ranged from 52.04 – 84.23 mg/100 g, this showed that the process of drying reduced the tannin content of the products. According to Lowor and Agyente-Badu [40] the tannin content of cashew range from 145 – 512 mg/100 ml. From the result, it was evident that banana contributed to the tannin content of the fruit bars because according to Kyamuhangire et al. [41], ripe banana pulp contains some amount of tannin.

Table 3. Proximate composition of the banana-cashew apple fruit bar samples

Samples	Moisture (%)	Crude fibre (%)	Ash (%)	Crude protein (%)	Crude fat (%)	Carbohydrate (%)	Energy value Kcal /100 g
B (100:0)	18.92^{a} ± 0.06	1.00^{a} ± 0.08	2.33^{a} ± 0.04	3.13^{ab} ± 0.06	0.10 ^{a} ± 0.02	74.51^{a} ± 0.18	311.42
BCA (90:10)	19.14^{a} ± 0.03	1.19^{ab} ± 0.04	2.39^{a} ± 0.10	3.06^{a} ±0.09	0.15^{ab} ± 0.01	74.06^{a} ± 0.28	309.83
BCA (80:20)	20.13^{b} ± 0.11	1.28^{b} ± 0.02	2.56^{ab} ± 0.07	3.20^{abc} ± 0.08	0.10 ^{a} ± 0.03	72.71^{b} ± 0.32	304.54
BCA (70:30)	20.84^{c} ± 0.30	1.70^{c} ± 0.02	2.67^{ab} ± 0.17	3.35^{bc} ± 0.03	0.23^{b} ± 0.02	71.20^{c} ± 0.54	300.27
BCA (60:40)	22.42^{d}± 0.02	1.90^{cd} ± 0.07	2.66^{ab} ± 0.08	3.38^{c} ± 0.04	0.24^{b} ± 0.04	69.38^{d} ± 0.11	293.2
BCA (50:50)	22.64^{d}± 0.09	2.05^{d} ± 0.09	2.76^{b} ± 0.06	3.32^{bc} ± 0.04	0.23^{b} ± 0.05	68.98 ^{d} ± 0.06	291.36

Values above are mean ± standard deviation of duplicate readings. Means on the same column with the same superscripts are not significantly ($p > 0.05$) different, while mean values on the same column with different superscripts are significantly ($p < 0.05$) different. Key: B = Banana pulp; BCA = Banana and cashew apple pulp

Table 4. Physicochemical properties of the banana-cashew apple fruit bar samples

Sample	pH	Brix (%)	Titratable acidity (%)
B (100:0)	4.65^{c} ± 0.05	11.85^{c} ± 0.05	0.23^{a} ± 0.01
BCA (90:10)	4.55^{c} ± 0.10	11.65^{c} ± 0.25	0.24^{a} ± 0.00
BCA (80:20)	4.40^{bc} ± 0.00	9.55^{b} ± 0.65	0.28^{b} ± 0.01
BCA (70:30)	4.20^{ab}± 0.10	9.45^{b} ± 0.55	0.30^{bc} ± 0.00
BCA (60:40)	4.05^{a} ± 0.05	7.85^{a} ± 0.35	0.33^{c} ± 0.01
BCA (50:50)	4.00^{a} ± 0.10	7.10^{a} ± 0.06	0.39^{d} ± 0.01

Values above are mean ± standard deviation of duplicate readings. Means on the same column with the same superscripts are not significantly (p > 0.05) different, while mean values on the same column with different superscripts are significantly (p < 0.05) different. Key: B = Banana pulp; BCA = Banana and cashew apple pulp

Table 5. Tannin content of the formulated fruit bar samples

Samples	Tannin content (mg/100 g)
B (100:0)	52.04^{a} ± 1.95
BCA (90:10)	63.21^{b} ± 3.32
BCA (80:20)	65.12^{b} ± 1.42
BCA (70:30)	79.62^{c} ± 0.82
BCA (60:40)	84.23^{c} ± 4.79
BCA (50:50)	80.13^{c} ± 1.89

Values above are mean ± standard deviation of duplicate readings. Means on the same column with the same superscripts are not significantly (p > 0.05) different, while mean values on the same column with different superscripts are significantly (p < 0.05) different. Key: B = Banana pulp; BCA = Banana and cashew apple pulp

3.3 Micronutrient Composition of the Banana-Cashew Apple Fruit Bar Samples

The potassium and vitamin C content of samples of fruit bars are presented in Table 6. The potassium content of the fruit bars ranged from 125 mg/100 g in sample BCA (50:50) to 220 mg/100 g in sample B (100:0). The plain banana fruit bar had the highest potassium content while the sample with the highest concentration of cashew apple had the lowest potassium content. The high content of potassium in the fruit bar samples could be attributed to the high potassium content of dates (*Phoenix dactylifera*) which was added as an ingredient and high potassium content of banana fruits. Morton [42] reported 648 mg in 100 g of dried date palm; while Dickison [43] reported 400 mg per 100 g of edible banana.

Vitamin C content of the fruit bar samples ranged from 25.66 mg/100 g in sample B (100:0) to 41.38 mg/100 g in sample BCA (50:50). There were no significant (p > 0.05) differences in the vitamin C content of the samples B (100:0), BCA (90:10) and BCA (80:20) and samples BCA (70:30), BCA (60:40) and BCA (50:50). It was observed that the vitamin C content of the fruit bar samples increased significantly with the increase in the concentration of cashew apple pulp. This could be attributed to the high vitamin C content of cashew apple. According to Lowor and Agyente-Badu [40], cashew apple juice is reported to contain five times as much vitamin C as citrus juice [18] and ten times as pineapple juice [17].

Table 6. Micronutrient composition of the banana-cashew apple fruit bar samples

Samples	Potassium (mg/100 g)	Vitamin C (mg/100 g)
B (100:0)	222.92^{b} ± 4.50	25.66^{a} ± 0.13
BCA (90:10)	211.00^{b} ± 18.00	26.51^{a} ± 0.30
BCA (80:20)	190.50^{b} ± 7.50	29.80^{ab} ± 2.21
BCA (70:30)	152.50^{a} ± 10.50	37.80^{bc} ± 0.02
BCA (60:40)	146.50^{a} ± 8.50	36.15^{bc} ± 4.37
BCA (50:50)	125.50^{a} ± 6.50	41.38^{c} ± 3.11

Values above are mean ± standard deviation of duplicate readings. Means on the same column with the same superscripts are not significantly (p > 0.05) different, while mean values on the same column with different superscripts are significantly (p < 0.05) different. Key: B = Banana pulp; BCA = Banana and cashew apple pulp

3.4 Sensory Qualities of the Banana-Cashew Apple Fruit Bar Samples

Table 7 shows the sensory qualities of the fruit bar samples. Colour is one of the important quality parameters of fruit bars which contribute to its aesthetic appeal. The mean scores for colour ranged from 4.90 in sample B (100:0) to 7.65 in sample BCA (80:20). The sample BCA (80:20) had the highest score (7.65) for colour while sample B (100:0) had the least mean score (4.90) for colour. The dark colour of the sample B (100:0) could be due to the high content of reducing sugar present in the banana fruit puree with the added sugar and the effect of heat. According to Hendel et al. [44], rate of browning is usually approximately proportional to the reducing sugar content. There were no significant ($p > 0.05$) differences between the colour of the samples B (100:0) and BCA (90:10) and samples BCA (80:20), BCA (70:30), BCA (60:40) and BCA (50:50).

The mean scores for appearance ranged from 4.6 in sample B (100:0) to 7.10 in sample BCA (50:50). The sample BCA (50:50) had the highest mean score for appearance while the sample B (100:0) had the least mean score (4.6). There were no significant ($p > 0.05$) differences between the samples with 80, 20, 30 and 40% of cashew apple pulp. The result also showed that the appearance of samples B (100:0) and BCA (90:10) were not liked by the consumers since their mean scores were less than 6 (slightly liked).

The mean scores for texture ranged from 5.95 in sample BCA (90:10) to 7.15 in sample BCA (50:50). Sample BCA (50:50) had the highest mean score. This showed that the sample was preferred more than the other samples of the formulated fruit bars in terms of texture. There were no significant ($p > 0.05$) difference between samples B (100:0), BCA (90:10), BCA (80:20), BCA (70:30) and BCA (60:40); and between samples BCA (50:50), BCA (60:40), BCA (70:30) and BCA (80:20).

The aroma of food is a very essential parameter in sensory qualities. The mean scores for aroma ranged from 6.55 in sample B (100:0) to 7.45 in sample BCA (50:50). This showed that the aroma of all the samples was liked by the panellists. There were no significant ($p > 0.05$) differences between samples B (100:0), BCA (90:10) and BCA (70:30). Also no significant ($p > 0.05$) difference existed among the samples with 10, 20, 30, 40 and 50% of cashew pulp. Sample BCA (80:20) with 20% of cashew pulp had the highest score for taste. There were no significant ($p > 0.05$) differences in the taste of samples B (100:0), BCA (90:10) and BCA (50:50). The mean score of the sample BCA (50:50) was within the range of slightly liked (6.80); this was due to the sour/astringent taste of the sample which was indicated by the panellists. The sour taste was attributed to the high concentration of cashew apple fruit.

The means score for chewiness ranged from 6.50 in sample B (100:0) to 7.45 in sample BCA (80:20). No significant ($p > 0.05$) difference existed in the chewiness of all the samples. The mean score for mouthfeel ranged from 6.30 in sample B (100:0) to 7.30 in sample BCA (80:10). There were no significant ($p > 0.05$) differences in the mouth feel of all the samples. Also the mean score for aftertaste ranged from 6.30 in sample B (100:10) to 7.10 in sample BCA (80:20). No significant ($p > 0.05$) differences existed in the aftertaste of all the samples.

The overall acceptability for the banana-cashew fruit bars ranged from 6.30 in plain banana bar (B (100:0)) to 7.75 in sample with 20 percent of cashew apple (BCA (80:20)). There were no significant ($p > 0.05$) differences in the overall acceptability of the all the samples with different levels of cashew [BCA (80:20), BCA (70:30), BCA (60:40), BCA (50:50)] except for sample BCA (90:10) which varied significantly ($p > 0.05$) without any difference with sample B (100:0).

Generally from the result, the mean score for overall acceptability of all the fruit bar samples with different levels of cashew apple pulp were more than 6.0 (slightly like). This implies that mixed fruit bars with 10 – 50% of cashew apple pulp could be produced without having a negative impact on the consumer preference.

3.5 Microbial Count (Cfu/G) of the Formulated Fruit Bars

Table 8 shows the microbial count of the fruit bars. The total viable counts (TVC) of samples range from 4.0×10^2 in the sample BCA (50:50) to 1.3×10^3 in sample B (100:0). The result showed that there was a decrease in the TVC as the concentration of cashew apple pulp increased, although it didn't follow a particular trend. This could be attributed to the increase in the acidity or decrease in pH level of the fruit bars as the concentration of cashew apple increased. Similar result was reported by

Table 7. Sensory quality of the banana-cashew apple fruit bar samples

Samples	Colour	Appearance	Texture	Aroma	Taste	Chewiness	Mouthfeel	Aftertaste	Overall acceptability
B (100:0)	$4.90^{a} \pm 0.31$	$4.60^{a} \pm 0.43$	$6.10^{a} \pm 0.38$	$6.55^{ab} \pm 0.18$	$5.90^{a} \pm 0.44$	$6.50^{a} \pm 0.46$	$6.30^{a} \pm 0.41$	$6.30^{a} \pm 0.46$	$6.30^{a} \pm 0.40$
BCA (90:10)	$5.15^{a} \pm 0.24$	$5.40^{a} \pm 0.31$	$5.95^{a} \pm 0.38$	$6.75^{ab} \pm 0.21$	$6.30^{ab} \pm 0.34$	$6.50^{a} \pm 0.41$	$6.65^{a} \pm 0.28$	$6.30^{a} \pm 0.42$	$6.35^{a} \pm 0.35$
BCA (80:20)	$7.65^{b} \pm 0.27$	$6.95^{b} \pm 0.31$	$6.85^{ab} \pm 0.26$	$7.25^{b} \pm 0.19$	$7.40^{c} \pm 0.26$	$7.45^{a} \pm 0.29$	$7.30^{a} \pm 0.28$	$7.10^{a} \pm 0.32$	$7.75^{b} \pm 0.23$
BCA (70:30)	$7.55^{b} \pm 1.28$	$6.80^{b} \pm 0.33$	$6.80^{ab} \pm 0.30$	$7.05^{ab} \pm 0.21$	$7.10^{bc} \pm 0.21$	$6.85^{a} \pm 0.25$	$6.95^{a} \pm 0.32$	$7.10^{a} \pm 0.22$	$7.30^{b} \pm 0.23$
BCA (60:40)	$6.85^{b} \pm 0.28$	$6.80^{b} \pm 0.34$	$6.80^{ab} \pm 0.24$	$7.40^{b} \pm 0.26$	$7.15^{bc} \pm 0.29$	$7.00^{a} \pm 0.29$	$6.50^{a} \pm 0.31$	$6.75^{a} \pm 1.26$	$7.10^{a\,b\,\backslash} \pm 0.26$
BCA (50:50)	$7.40^{b} \pm 0.27$	$7.10^{b} \pm 0.29$	$7.15^{b} \pm 0.30$	$7.45^{b} \pm 0.27$	$6.80^{abc} \pm 0.31$	$6.85^{a} \pm 0.36$	$6.70^{a} \pm 0.32$	$6.75^{a} \pm 0.30$	$7.15^{b} \pm 0.27$

Values above are mean ± standard deviation of duplicate readings. Means on the same column with the same superscripts are not significantly ($p > 0.05$) different, while mean values on the same column with different superscripts are significantly ($p < 0.05$) different. Key: B = Banana pulp; CA = Cashew apple pulp

Table 8. Microbial count (cfu/g) of the formulated fruit bar samples

Sample	Total viable count (cfu/g)	Mould count (cfu/g)
B (100:0)	1.3×10^3	4.0×10^1
BCA (90:10)	7.0×10^2	2.0×10^1
BCA (80:20)	1.1×10^3	5.0×10^1
BCA (70:30)	9.0×10^2	7.0×10^1
BCA (60:40)	6.0×10^2	3.0×10^1
BCA (50:50)	4.0×10^2	5.0×10^1

Values are means of duplicated readings. Key: B = Banana pulp; BCA = Banana and cashew apple pulp

Mbaeyi-Nwocha and Iwezor-Godwin [21] in cashew flavoured yoghurt, where the increase in the concentration of cashew pulp decreased the TVC ($2.4 \times 10^4 - 1.0 \times 10^4$ Cfu/ml). The presence of the total viable organisms could be attributed to the hygroscopic nature of the samples which made the samples to be susceptible to microbial attack. However, the microbial qualities of the fruit bars were within the range considered acceptable. Based on the standard for International Commission on Microbial Specification of Foods [45], total plate count ranging from 0 - 10^3 is acceptable, 10^4 - 10^5 is tolerable and 10^6 and above is unacceptable.

The mould count of the formulated fruit bar samples ranged from 2.0×10^1 in sample B (90:10) to 7.0×10^1 in samples BCA (60:40) and BCA (60:40). Since the presence of mould could cause the spoilage of products like fruit bars, anti-mycotin could be added to the products to prevent the growth of mould on the samples.

4. CONCLUSION AND RECOMMENDATION

From this study, it has shown that the utilization of cashew apple and its incorporation into already existing fruit bar like banana bar improved the nutritional and organoleptic qualities of the fruit bars. The addition of cashew apple improved the vitamin C content of the formulated fruit bars which is an essential vitamin needed in the body for growth and repair of tissue. It was also evident that the incorporation of the cashew apple into the already existing banana bar had no negative effect on its proximate composition; rather it had some positive effects like the increase in ash and fibre content of the products. The sample with 20% of cashew apple was highly preferred and accepted by the panellists among all other samples. However, all other samples were generally accepted since no sample had an average score less than 6 (slightly like). This implies that 10 – 50% of cashew apple pulp could be used to produce fruit bars without having any negative impact on the consumer acceptability. From the sensory evaluation, sample BCA (80:20) is rated as the best sample while from the nutritional stand point; sample BCA (50:50) was rated as the best. Therefore, from this work, it’s seen that there is a way forward for the utilization of the underutilized cashew apples so as to avoid its losses, conserve its huge nutritional composition in stable products and create varieties.

Due to the challenges encountered during the course of this study on procuring and keeping cashew apples till when needed for processing; it is therefore recommended that research on how to preserve cashew apple fruits in a dried stable form should be carried out as this will enable the availability and the utilization of the cashew apple all the year round. It is also recommended that studies on the effect of different kinds of dryer on the quality and acceptability of the banana-cashew apple fruit bar should be carried out to ascertain the best dryer that would give an acceptable quality product. This recommendation was made due to the challenges of drying with an oven dryer and its effect of the colour of the products. Finally, there is also need for a study on shelf stability of banana-cashew apple fruit bars and the best packaging material that may contribute to its stability.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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