

Quality Assessment of Enriched Snacks from Blends of Plantain Flour and Cashew Nut Protein Concentrate

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Abstract

This study was carried out to determine the quality of snacks made from unripe plantain flour and cashew nut protein concentrate. Composite flour was prepared from plantain flour and cashew nut protein concentrate into four ratios; 90:10 (SPC), 80:20 (SPR), 70:30 (SPI), 60:40 (SPT) and using 100% wheat flour as control (SPX). The functional properties (bulk density, water absorption capacity, solubility index and swelling capacity) of the composite flour were determined according to standard procedures. The proximate analysis of the cookies (Moisture content, protein, fat, ash, crude fibre and carbohydrate) were also determined and sensory analysis (Taste, colour, flavour, texture etc) of the cookies was determined. The bulk density of the flour blends ranged between 0.67 ± 0.02 to 0.82 ± 0.01 , the water absorption capacity ranged between 1.90 ± 0.04 to 2.98 ± 0.05 , Solubility index ranged between 0.10 ± 0.00 to 0.12 ± 0.01 and the Swelling capacity ranged between 5.43 ± 0.23 to 13.63 ± 0.12 . The proximate analysis of the cookies shows that moisture content ranged between 0.83 ± 0.01 to 4.1 ± 0.01 , fat content ranged between 11.67 ± 0.00 to 21.69 ± 0.58 , protein content ranged between 31.44 ± 0.00 to 35.54 ± 0.00 , ash content ranged between 1.40 ± 0.00 to 3.24 ± 0.01 , crude fiber ranged between 0.74 ± 0.01 to 1.55 ± 0.00 and carbohydrate content range between 36.99 ± 0.01 to 50.92 ± 0.01 . The panelist rated SPC as the best in terms of taste, flavour, texture and overall acceptability than other composite cookies.

Keywords: Protein Concentrate; Cashew Nut; Plantain Flour; Enriched Snacks; Functional Properties; Sensory Properties

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Introduction

Snack is a portion of food often smaller than a regular meal, generally eaten between meals. A snack should be balanced nutritionally, healthy, easy to eat, provide quick energy and should be of great taste [14]. Most snacks are subjectively classified as junk food because they typically have little or no nutritional value and high carbohydrate content, often with no contributing value towards nutrition and health. Hence, people are advised to eat more of natural snacks (fruits, vegetables, nuts and cereals) while avoiding high carbohydrates and low nutrition junk food, in order to control weight gain and general health problem [11].

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Plantain (*Musa paradisiaca*) is an important dietary source of carbohydrate in many parts of Africa, Asia and South America. It is consumed mainly for its vitamins and minerals contents. Plantains are usually harvested at a matured but unripe stage and ripen within 2-7 days. The high moisture content of plantain predisposes it to spoilage; hence it is dried to increase its shelf life. Plantain may be processed by frying, grilling, boiling and drying at different stages of maturity. The fruit is consumed mainly in Nigeria as boiled, fried or as snacks in form of chips, “*dodo Ikire*”, or as the popular roasted delicacy known as “*bole*” accompanied with fish, etc. [14].

Cashew (*Anacardium occidentale*) belongs to family *Anacardiaceae*, it is extremely hardy tree that grows on poor soil under various climatic conditions. It is a native to Brazil and is being extensively grown in India, East Africa, West Africa and Vietnam. These countries including Nigeria are the main producers of cashew [13]. The cashew nut is a highly nutritious and concentrated form of food, which contributes fat in the diet. It is widely used in a variety of ways, in different countries. Cashew is of high food value with 21% protein, 46% fat and 25% carbohydrates [22]. The cashew nut kernel has a pleasant taste and flavour, and can be eaten raw, fried and sometimes salted or sweetened with sugar [20]. Hence, this work was aimed at producing and evaluating the quality of enriched snacks from plantain flour and cashew nut protein concentrate.

Materials and Methods

Mature plantain fruits (*Musa paradisiaca*) were obtained from Lagos State Farm Settlement beside Lagos State Polytechnic, Ikorodu and Cashew nut was purchased from cashew processing plant in Federal University of Agriculture Abeokuta, Ogun State, Nigeria.

Flour Processing

Preparation of Plantain Flour: Plantain flour was produced by adopting the method of [19]. The plantain fruits were washed, peeled and sliced to about 5 mm diameter using a slicer. The slices were steamed for 15 minutes to inactivate enzymes. The pulp was drained and dried in a cabinet drier at 60°C for 24 hrs. After which the dried plantain slices was milled into flour. The flour was screened through a 0.25 mm sieve and packed in high density polyethylene (HDPE) until use.

Production of Defatted Cashew Nut Flour: Cashew kernels were milled and defatted using normal hexane by solvent extraction. The defatted flour was spread on stainless tray and oven dry at 50°C for six hour to remove the traces of solvent by evaporation [17].

Preparation of Cashew Nut Protein Concentrate

Cashew nut protein concentrate was prepared by the isoelectric precipitation method as described by [16]. An aliquot (100g) of defatted flour was mixed with 1000 ml of NaCl solution (0.15 M) and stirred at 35°C for 120 minutes. The pH was adjusted to 9.0 and the mixture was further stirred at 4°C for 30 min. The resultant slurry was then centrifuged at 2000g for 30 min at 4°C. The pellet obtained after recovering the supernatant, was dissolved in the initial NaCl solution at the above liquid to solid ratio under stirring. The pH was adjusted to the initial value and the slurry was stirred for 30 min at 4°C and then centrifuged as previously. The resultant supernatants of the two alkaline extractions were combined and one-part volume of 95 % (v/v) ethanol was added. The pH was adjusted to 4.5 under stirring and the precipitated protein was recovered by filtration under vacuum using a Whatman N°1 filter paper. The protein concentrate was dried at 50°C for 48h in an air convection oven, ground and passed through a 150 µm mesh sieve.

Preparation of Flour Blends

Composite blends of plantain flour and cashew nut protein concentrate was prepared as shown in Table 1. The flour was thoroughly mixed to obtain homogeneous blends. Samples were stored in airtight polythene bags at room temperature until ready for use.

Production of Snacks (Cookies)

The cookies were produced using the method of [10]. Fat and sugar was creamed to a smooth consistency; eggs and milk was added and mixed. The dry ingredients; flour, baking powder and salt was mixed together and added to the cream and mixed to form dough. The dough was kneaded into uniform thickness and cut into different shapes. They were placed in greased pans and baked at 150°C for 20 minutes. The cookies were stored in a plastic container with lid in a refrigerator at 4°C prior to analysis.

Ingredients	Samples				
	SPC	SPR	SPI	SPT	SPX
Plantain flour (%)	90	80	70	60	-
CNPC (%)	10	20	30	40	-
Wheat flour (%)	-	-	-	-	100

Table 1: Blend formulation of cookies samples.

Key:

SPC: 90% PF; 10% CNPC

SPR: 80% PF; 20% CNPC

SPI: 70% PF; 30% CNPC

SPT: 60% PF; 40% CNPC

SPX: 100% WF

Where PF: Plantain flour; WF: Wheat flour; CNPC: Cashew Nut Protein Concentrate

Analysis

Functional Properties of the Flour Blends: Water absorption capacity and bulk density was determined according to the method described by [3]. The solubility index and the swelling capacity of the flour were determined using the method of [9].

Proximate Composition of the Composite Cookies: Moisture content, fat, protein, ash, crude fibre and carbohydrate content protein was determined according to the method described by [7].

Sensory Analysis of the Composite Cookies: Consumer acceptability test was carried out on the coded samples SPC, SPR, SPI, SPT and SPX. The test was carried out using twenty panelists consisting of mainly female and male students of the Department of Food Technology, Yaba College of Technology. Panelists were instructed to evaluate taste, colour, flavour, texture and general acceptability of the cookies. A nine-point Hedonic scale was used with 1 = dislike extremely, 5 = neither like nor dislike, and 9 = like extremely [5]. The panelists were instructed to rinse their mouths with water after every sample and were asked to comment freely on samples on the questionnaires given to them.

Statistical Analysis: All statistical analysis was performed using Statistical Package for Social Science. Analysis of Variance (ANOVA) was used to determine the difference among samples. Duncan's multiple range tests was perform for multiple comparison [15].

Results and Discussion

Table 2 shows the functional properties of blends of plantain flour and cashew nut protein concentrate. Bulk density of the flour samples was found to range between 0.67 ± 0.02 to 0.82 ± 0.01 with SPC having the highest and SPX having the lowest bulk density. Increase in bulk density is desirable, because it offers greater packaging advantage as greater quantity may be packed within constant volume [21].

Water absorption capacity of the flour sample was found to range between 1.90 ± 0.04 to 2.98 ± 0.05 with SPC having the value of 2.98 ± 0.05 and SPX having the lowest value of 1.90 ± 0.04 . This is in contrary with the report of [2], who observed addition of soy-flour to plantain flour confers high water binding capacity which in turn improves the reconstitution and textural abilities obtainable from plantain flour.

Solubility index is an indication of how soluble the sample is and its ability to gelatinize with much residual particles [9]. Solubility index of the flour samples was found to range between 0.10 ± 0.00 to 0.12 ± 0.01 with SPC having the highest value of 0.12 ± 0.01 and SPT having the lowest value of 0.10 ± 0.00 .

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Sample	Bulk density (g/cm ³)	WAC (g/g)	Solubility %	Swelling %
SPC	0.82 ± 0.01 ^d	2.98 ± 0.05 ^d	0.12 ± 0.01 ^c	11.77 ± 0.06 ^d
SPR	0.76 ± 0.01 ^c	2.85 ± 0.06 ^{cd}	0.12 ± 0.00 ^{bc}	11.43 ± 0.12 ^c
SPI	0.74 ± 0.00 ^{bc}	2.80 ± 0.10 ^c	0.10 ± 0.01 ^a	9.57 ± 0.12 ^b
SPT	0.73 ± 0.02 ^b	2.60 ± 0.15 ^b	0.10 ± 0.00 ^a	5.43 ± 0.23 ^a
SPX	0.67 ± 0.02 ^a	1.90 ± 0.04 ^a	0.11 ± 0.01 ^b	13.63 ± 0.12 ^e

Values are mean of triplicates ± standard deviation

Different Letters within the same column means that samples are significantly ($p < 0.05$) different form one another.

Table 2: Functional Properties of Flour Blends.

Swelling capacity of the flour samples was found to range between 5.43 ± 0.23 to 13.63 ± 0.12 to with SPX having the highest value of 13.63 ± 0.12 and SPT having the lowest value of 5.43 ± 0.23 . The swelling capacity of the flours depends on the size of particles, types of variety and type of the processing method or unit operation [22].

The proximate composition of the cookies produced from blends of plantain flour and cashew nut protein concentrate are presented in Table 3. The % moisture content of the cookies was found to range between 0.83 ± 0.01 to 4.18 ± 0.01 with SPC having the highest value and SPT having the lowest value for moisture content. The low moisture content of the snacks is important because, it will help in extending the shelf life if adequately protected, by inhibiting the development of contaminating microorganism, whose growth and activities are favoured by presence of moisture [20].

Sample	%Moisture	%Fat	%Protein	%Ash	%Crude fibre	%CHO
SPC	4.18 ± 0.01 ^e	20.39 ± 0.00 ^c	32.49 ± 0.01 ^b	2.40 ± 0.00 ^b	1.15 ± 0.00 ^b	39.38 ± 0.01 ^b
SPR	1.74 ± 0.01 ^b	19.40 ± 0.01 ^b	31.44 ± 0.00 ^a	3.00 ± 0.00 ^d	1.25 ± 0.01 ^d	43.17 ± 0.01 ^d
SPI	2.54 ± 0.00 ^c	20.37 ± 0.01 ^c	32.82 ± 0.01 ^d	3.24 ± 0.01 ^e	1.55 ± 0.00 ^e	39.48 ± 0.01 ^c
SPT	0.83 ± 0.01 ^a	11.67 ± 0.00 ^a	32.50 ± 0.00 ^c	2.89 ± 0.00 ^c	1.19 ± 0.00 ^c	50.92 ± 0.01 ^e
SPX	3.63 ± 0.01 ^d	21.69 ± 0.58 ^d	35.54 ± 0.00 ^e	1.40 ± 0.00 ^a	0.74 ± 0.01 ^a	36.99 ± 0.01 ^a

Values are mean of triplicates ± standard deviation

Different Letters within the same column means that samples are significantly ($p < 0.05$) different form one another.

Table 3: Proximate Analysis of Cookies from Blends of Plantain flour and Cashew Nut Protein Concentrate.

The fat content of 49.1% in cashew nut kernel was reported by [4]. Fat plays a role in determining the shelf life of foods. The % fat content of the cookies was found to range between 11.67 ± 0.00 to 21.69 ± 0.58 with SPX having the highest value of 21.69 ± 0.58 and SPT having the lowest value of 11.67 ± 0.00 .

The % protein content of the cookies was found to range between 31.44 and 35.54 with SPX having the highest value and SPR having the lowest value for protein content. The variation in the crude protein content may be due to the ingredient used in their formulations [20].

Ash is a non- organic compound containing mineral content of food and nutritionally it aids in the metabolism of other organic compounds such as fat and carbohydrate [18]. The % ash content of the cookies was found to range between 1.40 ± 0.00 to 3.24 ± 0.01

with SPI having the highest value and SPX having the lowest value for ash content. The values were however; close to the range (1.34-2.58%) reported by [12] for banana- wheat composite cake.

The % crude fiber content of the cookies was found to range between 0.74 to 1.55% SPI having the highest value of 1.55 ± 0.00 and SPX having the lowest value of 0.74 ± 0.01 . Crude fiber helps in the maintenance of normal peristaltic movement of the intestinal tract hence diets containing low fiber could cause constipation and eventually lead to colon diseases (piles, cancer and appendicitis) [4].

The % carbohydrate content of the cookies was found to range between 36.99 to 50.92% with SPT having the highest value and SPX having the lowest value for carbohydrate content. The carbohydrate content of the cookies differed significantly ($P < 0.05$) among all the samples.

Table 4 shows the sensory score of cookies from plantain flour and cashew nut protein concentrate. Taste is a primary factor in determining the acceptability of any product that has the highest impact in determining the market success of product [6]. The taste of the cookies was found to range between 5.05 ± 1.54 to 8.15 ± 0.88 with SPX having the highest score and SPI having the lowest score for taste.

Sample	Taste	Colour	Flavour	Texture	General acceptability
SPC	6.60 ± 1.14^b	5.60 ± 1.60^a	6.30 ± 1.08^b	6.85 ± 1.66^{ab}	6.75 ± 0.97^b
SPR	5.80 ± 1.51^{ab}	5.90 ± 1.98^a	5.75 ± 1.62^{ab}	6.30 ± 1.75^a	5.90 ± 1.45^a
SPI	5.05 ± 1.54^a	4.95 ± 1.23^a	5.35 ± 1.35^a	6.10 ± 1.74^a	5.20 ± 1.44^a
SPT	5.20 ± 1.79^a	5.15 ± 1.46^a	5.85 ± 1.35^{ab}	6.40 ± 1.43^a	5.80 ± 1.70^a
SPX	8.15 ± 0.88^c	8.10 ± 0.91^b	7.90 ± 0.91^c	7.55 ± 1.39^b	8.35 ± 0.67^c

Values are mean of triplicates \pm standard deviation

Different Letters within the same column means that samples are significantly ($p < 0.05$) different from one another.

Table 4: Sensory Score of Cookies from Blends of Plantain Flour and Cashew Nut Protein Concentrate.

The colour of the cookies was found to range between 4.95 ± 1.23 to 8.10 ± 0.91 with SPX having the highest score and SPI having the lowest score for colour. Colour is a very important parameter in judging properly baked biscuits that not only reflect the suitable raw material used for preparation but also provides information about the formulation and quality of the product [1].

The flavour of the cookies was found to range between 5.35 ± 1.35 to 7.90 ± 0.91 with SPX having the highest score and SPI having the lowest score for flavour. The substitution level of cashew nut protein concentrate can influence the flavour of the cookies because cashew nut is highly nutritious and has a pleasant taste and flavor. However, this is in line with the work of [8] who reported a significant difference in flavour of plantain biscuits compared with 100% wheat biscuit.

Texture (Crispiness) is a parameter perceived by the mouth feel. The texture of the cookies was found to range between 6.10 ± 1.74 to 7.55 ± 1.39 with SPX having the highest score and SPI having the lowest score for texture.

The general acceptability of the cookies was found to range between 5.20 ± 1.44 to 8.35 ± 0.67 with SPX having the highest score and SPI having the lowest score for general acceptability. Consumer determines the acceptability of a food product from their perception about the product.

Conclusion

The study has shown that composite flour for baking of snacks can be produced from blends of unripe plantain and cashew nut protein concentrate.

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The inclusion of the cashew nut protein concentrate significantly improved the protein content of the cookies. The cookies from sample SPI has the highest protein content with low carbohydrate content which could help in combating protein energy malnutrition.

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