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Chemical, Sensory and Microbiological Properties of Cookies Produced From Maize, African Yam Bean and Plantain Composite Flour

Research Article

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Abstract

Chemical, sensory and microbiological properties of cookies produced from maize (*Zea mays*), African yam bean (*Sphenostylis stenocarpa*) and plantain (*Musa paradisiaca*) composite flours were studied. Cookies comprising different compositions of African yam bean (AYB), maize and plantain flours were prepared and coded samples B, C and D while cookie from 100% wheat (sample A) served as control. Cookies were subjected to chemical, sensory and microbial evaluation using standard methods of analyses. Cookies made from composite blends had higher levels of proteins, fat, moisture, Beta-carotene (pro-vitamin A), vitamin C and Iron. Carbohydrate level of the control sample (100% wheat) was higher than the cookies made from composite flour. There was no significant ($p \geq 0.05$) difference in the energy values of all the samples. Cookies produced from 70% maize, 20% AYB and 10% plantain composite flour had the highest score for general acceptability and compared favourable with the control cookie for almost all sensory parameters examined. Microbiological analysis (total viable count and fungal count) indicated that all the cookies prepared were free of microorganisms for up to two months of storage under ambient conditions. This study revealed that maize, African yam bean and plantain composite flour could be used in the production of nutritious and microbiological shelf-stable biscuits.

Keywords: Chemical; Sensory Properties; Microbiological; Cookies; Composite Flour

Introduction

Cookies are popular foodstuff consumed by a wide range of populations due to their varied taste, long shelf-life and relatively low cost [1]. Cookies are consumed extensively in Nigeria as a snack, ready-to-eat and convenient food. Cookies are majorly processed from wheat flour. Like most cereal-based foods. Cookies are good sources of carbohydrates but low in proteins and vitamin A, a major micronutrient problem among children [2]. Attempts are being made to improve the nutritive value and sensory qualities of cookies by modifying their nutritive composition. This involves promoting the use of non-wheat flour or composite flour in which locally grown crops with high protein value replaces wheat flour thereby overcoming the challenge of continuous dependence on wheat importation which could lead to food insecurity. African yam bean (*Sphenostylis stenocarpa*) is a nutrient dense, but highly underutilized legume that is predominantly cultivated in Nigeria. African yam bean seed contains 21-29% protein; it is a good source of fibre, carbohydrates and rich in minerals [3].

Maize (*Zea mays*) also referred to as corn, belongs to the family gramineae and is the third most important cereal crop in the world, next to rice and wheat, with regards to cultivation areas and total production [4]. Maize is a high carbohydrate food with 68% starch, 10.5% protein, 5.4% fat and minerals. The corn flour can be used to prepare various food products.

Plantains (*Musa paradisiaca*) are potent sources of micronutrients

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especially pro-vitamin A, vitamin C, potassium and fibre [5]. Over 23 million metric tons of plantains are produced in Nigeria annually. However, the utilization of this popular plant fruits is still limited to the traditionally steamed, boiled or fried and roasted plantain [6]. Adeniyi et al. reported that firm ripe plantains are good sources of vitamins and minerals in addition to being low in fat [7]. USDA reported that plantains provide a better source of vitamin A than most staples. Plantains are low sodium food recommended for low sodium diets [4].

From literature review, there is scanty information about any attempt to produce cookies from African yam bean, maize and plantain composite flour. This study is therefore aimed at evaluating the chemical sensory and microbiological properties of cookies produced from African yam bean, maize and plantain composite flour.

Materials and Methods

Sources of Raw Materials

African yam bean (AYB) seeds, maize grains and firm ripe plantain were obtained from Anyigba Central Market, Kogi State, Nigeria.

Preparation of African Yam Bean (AYB) Flour

AYB flour was prepared following the method derscribed by Yusufu, et al. [5]. AYB seeds were cleaned of dirts, parboiled (100 °C for 20 min) in an aluminum pot with lid. The parboiled seeds were drained for 5 minutes, dehulled manually and washed with clean water. The seeds were oven dried and toasted at 150 °C for 1 hr. The toasted seeds were milled in a hammer mill and sieved through a 500µm mesh. The flour was packaged in an air tight container.

Preparation of Maize Flour

Table 1: Chemical Composition of Cookies Produced from Maize, AYB and Plantain Composite Flour.

Composition	Sample			
	A	B	C	D
Protein (%)	11.00±0.01^{c}	16.10±0.03^{b}	16.28±0.08^{b}	18.71±0.03^{a}
Moisture (%)	4.51±0.07^{c}	6.20±0.14^{b}	7.10±1.13^{b}	9.52±1.12^{a}
Ash (%)	0.81±0.00^{c}	3.21±0.06^{a}	4.12±0.02^{a}	5.10±0.03^{a}
Fat (%)	10.21±0.05^{c}	13.00±1.13^{b}	14.01±1.13^{b}	17.11±0.12^{a}
Fibre (%)	3.10±0.03^{a}	3.24±0.15^{a}	3.92±0.22^{a}	4.55±0.18^{a}
Carbohydrate (%)	70.37±0.16^{a}	58.25±1.51^{b}	54.48±2.58^{b}	45.01±1.48^{c}
Energy (Kcal/100g)	417.37±3.11^{a}	414.00±1.49^{a}	408.92±1.37^{a}	408.0±1.71^{a}
Beta-Carotene (Mg/100g)	0.01±0.00^{c}	2.32±1.12^{b}	4.11±0.02^{a}	5.31±0.17^{a}
Ca (Mg/100g)	48.30±1.01^{b}	50.01±0.01^{b}	55.10±0.03^{a}	57.02±0.11^{a}
K (Mg/100g)	216.00±3.21^{c}	320.55±2.73^{b}	400.51±2.17^{a}	430.00±2.30^{a}
Vit. C (Mg/100g)	4.11±0.03^{b}	5.21±0.02^{b}	6.21±1.15^{a}	7.11±0.12^{a}
Fe (Mg/100g)	1.82±0.15^{c}	3.10±0.04^{b}	3.52±0.05^{a}	4.11±0.14^{a}

Values are means of triplicate determinations. Means followed by the same superscript along rows were not significantly (p≥0.05) different.
A = Cookies made from 100% wheat (control)
B = Cookies made from blends of maize, AYB and plantain at the ratio of 70: 20: 10 (Maize: AYB: Plantain)
C = Cookies made from blends of maize, AYB and plantain at the ratio of 60: 20: 20 (Maize, AYB and Plantain)
D = Cookies made from blends of maize, AYB and plantain at the ratio of 50: 25: 25 (Maize, AYB and Plantain).

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Table 2: Means Sensory Scores of Cookies Produced from Maize, AYB and Plantain Composite Flour.

Sample	Crust Color	Texture	Flavor	Crunchiness	General Acceptebility
A	8.2[a]	7.5[a]	7.1[a]	6.8a	7.6[a]
B	7.8a	7.3[a]	6.1[b]	7.4[a]	7.2[a]
C	6.1[b]	7.2[a]	6.0[b]	7.5[a]	5.8[b]
D	5.0[c]	7.0[a]	5.5[c]	7.0[a]	5.0[c]

Mean within a column with the same superscript were not significantly (p≥0.05) different. Samples were evaluated on a-9 point Hedonic Scale (9 = Liked extremely and 1 = Disliked extremely).

Maize flour was processed using the method described by Enwere [3]. The grains were cleaned and washed. The cleaned grains were boiled in water at 100 ˚C for 10 minutes and drained for 10 minutes. The grains were dried in an oven (uniscope 9053) at 70 ˚C for 1 hr and the dried grains were dehulled by the use of hands and winnowed. The dehulled grains were milled and sieved (500µm) and packaged.

Preparation of Plantain Flour

The method described by Enwere was used to prepare the plantain flour [3]. Firm ripe plantain fruits were washed to remove adhering soil particles, peeled and sliced into thin thickness of about 2mm. 5.25ml of 2.0% sodium metabisulphite was added to each 500g weighed chopped pulp and allowed to stand for 20 min and dried in the cabinet dryer at 50 ˚C for 24hr. The dried plantain slices were milled into flour using a hammer mill and sieved through 500µm sieve. The flour was packaged and sealed in polyethylene bag.

Blend Formulation

Maize, AYB and plantain flour were blended in a proportion of 70: 20: 10 (maize: AYB: Plantain) and coded sample B, 60: 20: 20 to produce sample C and 50: 25: 25 to produce sample D. Cookies made from 100% wheat was coded sample A and served as control.

Proportions of Ingredients

The proportions of ingredients used in cookies production were as described by Chinma et al. with slight modification [1]. The ingredients consist of 100g flour, 53.0g of sugar, 26.5g of margarine, 1.10g of sodium bicarbonate, 0.89g of sodium chloride, 7.5ml of unsweetened evaporated liquid milk (peak) and 12.0ml of water.

Preparation of Cookies

The flour was mixed with other ingredients and blended thoroughly to form dough. The dough was placed on a clean table, rolled and cut out into required shapes, baked in an oven at 180 ˚C for 30 minutes. The cookies were allowed to cool and packaged in low density polyethylene bags of thickness 0.5mm and stored in air tight containers for further analysis.

Chemical Analysis

The moisture, crude protein, fat, crude fibre and ash contents were determined following the procedure outlined by AOAC [8], while carbohydrate was calculated by difference [9]. Energy was calculated using Atwater factors (9x fat, 4x protein and 4x carbohydrate). Beta carotene, Vitamin C, potassium and calcium contents were determined following the methods described by Onwuka [9].

Sensory Evaluation

Sensory evaluation was conducted mid-afternoon (1.00-2.00 p.m.) in a sensory evaluation room. A-20 member Panel was trained on sensory attributes for the evaluation. The scores were based on the intensity of organoleptic quality attributes of taste, crust color, flavor, texture and overall acceptability. Each sensory attribute was rated on a-9 point Hedonic Scale (1= disliked extremely while 9= liked extremely).

Microbiological Analysis

Microbiological analyses were carried out according to the method described by Jideani [10]. One gram of sample was homogenized in 10ml of $^1/_4$ Strength Ringer's Solution. Dilutions were made by mixing 1.0ml of the homogenate in 9.0ml of the sterile diluent to obtain 10^{-1} dilution. The dilution was then made up to 10^{-2}, 10^{-3} and 10^{-4}. Total viable counts of bacteria were determined by enumerating the colony forming units (cfu) by pour plating on nutrient agar plates and cultured at 37 ˚C for 48hrs. The number of colony forming units on each plate was counted using colony counter and expressed as cfu/g.

Table 3: Microbial Population of Cookies Produced from Maize, AYB and Plantain Composite Flour during 4 Months of Storage.

Storage Periods (Months)	Sample							
	A		B		C		D	
	TVC	FC	TVC	FC	TVC	FC	TVC	FC
1	x	x	x	x	x	x	x	x
2	x	x	x	x	x	x	x	x
3	x	x	$1.2x10^{3c}$	x	$2.6x10^{3b}$	x	$3.4x10^{3a}$	x
4	$1.10x10^{2b}$	x	$5.1x10^{4b}$	$2.0x10^{2a}$	$6.3x10^{4a}$	$2.5x10^{2a}$	$6.8x10^{4a}$	$2.8x10^{2a}$

Means followed by the same superscript along rows are not significantly (p≥0.05) different.
Results are means of triplicate count.
X = No visible growth
TVC = Total viable count
FC = Fungal count.

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Total fungal counts were determined by pour plating on potato dextrose agar plates supplemented with 1.0% tartaric acid to inhibit bacterial growth and incubated at room temperature (30±2 °C) for 4-6 days. The number of colonies were expressed as cfu/g. All the analyses were carried out in triplicates.

Statistical Analysis

Data were subjected to analysis of variance as described by Egbekun and Akubor [11]. Least significance difference (LSD) test was used to separate means where significant. Significance was accepted at ($p \leq 0.05$).

Results and Discussion

Chemical Composition of the Cookies

The chemical composition of cookies is shown in Table 1. There was significant difference ($p \leq 0.05$) between cookies made from control (100% wheat) and composite flours in terms of protein, moisture, ash and carbohydrate. A gradual decrease in carbohydrate with increasing level of AYB flour inclusion was observed while the reverse was the case with protein content. This is in agreement with Yusufu et al. [12] who reported a decrease in carbohydrate content of cookies when green bean flour was blended with wheat to produce cookies. Sample D had the highest level of protein (18.71%). The health benefits of proteins are well documented. The energy value ranged from 408Kcal in sample D to 417 Kcal in sample A with no significant (($p \geq 0.05$) difference among the samples.

World Health Organization (WHO) recommended 1790Kcal to 2500 Kcal/day of energy for children aged between 5 and 19 years [4]. This suggests that biscuits prepared from flour blends comprising of maize, AYB and plantain could be included in school feeding programmes for children. Beta carotene and Vitamin C increased significantly ($p \leq 0.05$) with increased level of plantain flour. Beta carotene is a pro-vitamin A. Vitamin A is a powerful natural anti-oxidant and required by the body for maintaining the integrity of skin and mucus membranes. It is an essential vitamin for good visual sight. Vitamin C is vital in iron metabolism and subsequent fight against iron deficiency anaemia Akubor [13].

The composite cookies were higher in all the minerals (Ca, K and Fe) than the control. This could be attributed to the relatively higher mineral content of AYB and plantain. From the results of the mineral composition of cookies shown in Table 1, it is evident that cookies prepared from the composite flour of maize, AYB and plantain are more nutritious than 100% wheat flour cookies. This study is in agreement with the values reported by Chinma et al. for tiger nut and pigeon pear flour cookies [1].

The sensory characteristics of cookies are shown in Table 2. The statistical analysis showed that there was significant difference (($p \leq 0.05$) among the cookie samples in crust color. Control sample (A) had the highest score while sample D had the least score. There was no significant ($p \geq 0.05$) difference in texture. The panelists showed preference for sample A in terms of flavor. The inherent beany flavor of the composite cookies may have accounted for the lower rating by the panelists. All the samples were scored high in terms of crunchiness. For the general acceptability, cookies prepared from 70% maize, 20% AYB and 10% plantain composite flour had the highest score next to control sample. Sample B therefore, competed favorably with 100% wheat cookies.

Result of microbiological analysis of the samples is shown in Table 3. No visible growth was observed on all the samples during two months of storage. This is an indication that the cookies were prepared under good hygienic condition and the integrity of the packaging material used was not compromised. Total viable count results showed growth on all the samples except sample A after the third month of storage. This could result from the increased level of proteins and fats of the sample as shown on Table 1. Adams and Moss reported that spoilage organisms grow faster in a medium that is highly nutritious. The forth month of storage showed fungal growth on samples B, C and D [14]. The control had no visible fungal growth throughout the four months of storage. Fungal growth on foods could lead to deposit of mycotoxins on foods which are a public health concern. This study has demonstrated that cookies produced from composite flour of maize, AYB and plantain are microbiologically safe during two months of storage but could pose health risk after three months of storage.

Conclusion

This study has demonstrated that nutritious and acceptable cookies that are microbiologically shelf-stable could be produced from composite flour made from maize, AYB and plantain. The use of such composite flour will reduce over dependence on imported wheat flour. Since Nigeria climate is not favourable for wheat production, a lot of foreign exchange may be conserved and food security may be guaranteed if such composite flour from local crops are used.

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