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FUNCTIONAL CHARACTERISTICS AND PHYSICAL PROPERTIES OF COOKIES PRODUCED FROM WHEAT, PLANTAIN AND WHOLE GROUNDNUT PASTE

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Abstract
The aim of the study was to determine the functional characteristics of cookies produced from plantain-wheat composite flour blends enriched with whole groundnut paste and physical properties of cookies produced from the composite flour. Plantains were processed into flour while wheat flour was obtained and groundnuts were processed into paste. The flours were mixed in the following proportion: 100:0:0, 90:5:5, 80:5:15, 70:10:20 and 60:15:25 respectively. The functional properties of the flour blends were determined using standard methods. Foaming capacity, bulk density, water absorption capacity, oil absorption capacity, foaming stability and swelling capacity were in the range 0.00 - 7.14 %, 1.00 - 3.00 g/ml/, 200.00- 310.00 %, 40.00 - 182.00 %, 0.00 – 4.64 % and 1.90 -5.20 % respectively. The physical properties of cookies showed significant ($p < 0.05$) variations among the samples. Height ranged from 8.20 to 12.97 cm, thickness (0.63 to 0.90 cm), diameter (0.12 to 4.83 cm) and spread ratio (0.17 to 7.27). Plantain-wheat composite flour blends enriched with groundnut paste exhibit diverse functional properties, making them suitable for various food formulations.

Keywords: *Cookies, Functional, Physical*

1.0 INTRODUCTION

Composite flour can be described as a mixture of several flours obtained from root, tuber, cereal and legume, with or without the addition of wheat flour, which is created to satisfy specific functional characteristics and nutrient composition (Olapade and Adeyemo, 2014). Wheat flour the main ingredient for cookies is mainly imported to Nigeria because of unfavorable climatic conditions for its commercial growth (FAO, 2010). This importation places a considerable burden on the foreign exchange reserve of Nigeria's economy. In an effort to help the third world countries reduce their importation, the FAO in 1957 started a study on the technological feasibility of the use of composite for the production of cookies, bread and pastry products. Cookies have been suggested as a better use of composite flour than bread due to their ready to eat form, wide consumption, relatively long shelf life and good eating quality (Olapade and Adeyemo, 2014). Cookies are ready-to-eat, convenient and inexpensive food snacks produced from unpalatable dough that is transformed into a light porous, readily digestible and appetizing product through the application of heat. The principal ingredients are wheat flour, fat, sugar and water, while other optional ingredients include milk, salt, flavoring agent, aerating agent and other food additives (Olapade and Adeyemo, 2014)

Groundnut, also known as peanut or *Arachis hypogaea*, is a widely cultivated legume crop appreciated for its nutritious seeds. It is native to South America and has been cultivated for thousands of years. Groundnuts have become a staple food and

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a valuable source of oil and protein for many cultures around the world. They are not only enjoyed in their raw form but also processed into various products such as peanut butter, oil, and confectioneries. With their nutritional benefits and versatility, groundnut, play a significant role in both agricultural and culinary landscapes (Thomas *et al*., 2016).

Plantain is an important food crop in tropical and subtropical regions, worldwide. In sub-saharan Africa, banana and plantain provide more than 25% of the energy needs of 70 million people (Daniells *et al*., 2011). Pulp from matured green plantain is rich in sugar (2-31%) micronutrients viz potassium (440mg/100g), phosphorus (32mg/100g) and magnesium (32mg/100g), Vitamin C (20mg/100g) and vitamin B (Robinson and Sauco, 2013).

2.0 MATERIALS AND METHODS

2.1 Sources of Materials

Plantains and groundnut used in this research were purchased from Oja Ago market, Ado Ekiti. Other materials such as wheat flour, baking powder, baking fat, sugar were also purchased from OjaBisi.

2.2 Methodology

2.2.1 Production of Plantain Flour

Plantains were sorted, washed in water to remove dirts and adhered soil. They were peeled, sliced and then sun dried for four days. After drying, the dried plantain chips were milled into flour and packaged in nylon.

2.2.2 Production of Groundnut Paste

Groundnuts were roasted for 15 minutes, de-hulled. Dehulled groundnut were ground using a home-made stainless steel roller crusher and particles between 2.4 and 4.8 mm (mesh 8-4, Tyler standard screen scale) were selected using an automated screen.

2.2.3 Production of Cookies

The plantain- wheat flour blends and groundnut paste with other ingredients were weighed accurately using the recipe in Table 2 below. The pre-weighed flour, sugar, salt and baking powder were mixed thoroughly, then butter was added and mixed properly. This was followed by the addition of water and milk, the mixture was then mixed properly to make adequate dough. The dough was rolled on a board using rolling pin to a thickness of 0.2 – 0.3cm. The rolled dough was cut into shapes and arranged on a greased tray and baked at 180°C for 25minutes in a preheated oven. The cookies were brought out, cooled and packaged in nylon. Cookies produced from plantain flour was used as control.

Plantain
↓
Sorting/Washing
↓
Peeling
↓
Slicing
↓
Drying
↓
Milling
↓
Plantain Flour

Fig. 1: Flow Chart for the Production of Plantain Flour

Groundnut
↓
Cleaning
↓
Roasting (15 minutes)
↓
Dehulling
↓
Milling
↓
Groundnut paste

Fig. 2: Flow Chart for the Production of Groundnut Paste

Composite flour
↓
Egg whisked
↓
Dry ingredients mixed together with creamed mixture
↓
Addition of groundnut paste
↓
30ml of water added and mixed again
↓
Dough formed
↓
Dough rolled on a flat board
↓
Cut into shapes
↓
Placed in a greased tray
↓
Baked at 150^{o}C for 15minutes
↓
Cookies
↓
Packaging

Fig. 3: Flow Chart for the Production of Cookie

2.3 Formulation of Plantain flour-groundnut paste

Plantain flour was mixed with wheat flour and groundnut paste in this following proportions ratio: 100:0:0, 90:5:5, 80:5:15, 70:10:20 and 60:15:25 respectively. The flour were then thoroughly mixed together manually to ensure homogeneity of the flour blends.

Table 1: Formulation Table

Samples	Plantain flour (%)	Wheat flour (%)	Groundnut paste (%)
A	100	0	0
B	90	5	5
C	80	5	15
D	70	10	20
E	60	15	25

Table 2: Recipe for the Production of Cookies

Ingredients	%
Composite flour	100
Sugar	28
Salt	1
Powder milk	5
Baking fat	32
Baking powder	1

2.4 Determination of Functional Properties

2.4.1 Loose Bulk Density (LBD) and Packed Bulk Density (PBD)

For LBD, 10 ml graduated measuring cylinder was weighed and the cylinder was gently filled to mark with the sample, the weight and volume of the filled measuring cylinder was noted. For PBD, the filled measuring cylinder was continuously tapped until there was no reduction in the level of the sample. The new weight and volume was noted.

$$\text{Packed/Loose bulk density (g/ml)} = \frac{weight\ of\ sample\ (g)}{volume\ of\ sample\ (ml)}$$

2.4.2 Water Absorption Capacity (WAC) and Oil Absorption Capacity (OAC)

1 gram sample was mixed with 10 ml of distilled water in a centrifuge tube. The contents were mixed for 30s and allowed to stand for 30minutes.It was then centrifuged at 4000rpm for 30 min. The supernatant was carefully decanted and measured. The water absorption capacity was expressed ml of water absorbed per gram of the sample. OAC was carried out using similar procedure but instead of water, vegetable oil was used.

2.4.3 Swelling Capacity (SC)

1g of the sample was weighed into a weighed centrifuge tube, 10ml of distilled water was poured into the centrifuge tube and the content mixed with spatula. The water bath was set at 60^{o}c and the centrifuge tube was heated in the water bath for 30minutes. The supernatant was thereafter decanted, the tube was allowed to cool and then weighed**.** Swelling capacity was calculated as follows:

$$\text{Swelling Capacity} = \frac{weight\ of\ swollen\ sample}{weight\ of\ dry\ sample}$$

2.4.4 Foaming Capacity

2 gram of the sample was weighed into a 100ml graduated measuring cylinder and water was added up to 90ml mark, the cylinder was covered tightly and shaked vigorously for 5 minutes. The volume of foam produced was read after 30 seconds

Foaming Capacity= $\frac{volume\ after\ shaking - volume\ before\ shaking}{volume\ before\ shaking}$

2.5 Evaluation of Physical Properties

The weight of the cookies was determined by using weighing balance (g). The diameter of cookies was measured with ruler in cm .The thickness was measured by stacking 5 cookies on top of each other and the total height was measured with ruler then the readings was divided by 5 to get the thickness of 1 cookie. The procedure was repeated 3 times to get the replicate readings.

2.6 Statistical Analysis

The data obtained were were subjected to statistical analysis using SPSS version 2.1 and mean were separated using the Duncan multiple range test at the level of $P<0.05$

3.0 RESULTS AND DISCUSSION

3.1 Functional Properties

The swelling capacity of the samples ranged between 1.90 to 5.20% (Table 1). Sample C (80% plantain flour, 5%wheat flour, 15% groundnut paste) had the highest swelling power of 5.20. The swelling power has been related to the associative binding forces within the starch granules (Eke-Ejiofor, 2012). There were fluctuation in the swelling power of the flour blends, however plantain flour higher swelling power than other samples enriched with wheat flour and groundnut paste. Swelling is important for moisture retention and can affect the overall texture of the cookies (Wong and Moey, 2017).

Water Absorption Capacity (WAC) ranged from 200.0 to 310.00% and sample A (100% plantain flour) had the highest value of 310.00%, followed by sample C (80% plantain flour, 5%wheat flour, 15% groundnut paste). High WAC in sample A indicate that cookies produced from plantain flour had good moisture retention properties, which may contribute to their softness and texture (Braga *et al.,* 2019). The relatively high water absorption of flour blends suggest that they will contribute positively to yield and constituency during processing (Osundahunsi *et al*., 2013).

The oil absorption capacity of the samples ranged from 40.00 to 180.00%. Sample E (60% plantain flour, 15%wheat flour, 25% groundnut paste) had the highest value (180%) and could be as a result of high percentage of groundnut paste. This may enhance the potential of flour for use in fat based foods. High OAC suggests that the cookies can retain oil and may have a moist and tender texture (Ojokoh *et al.,* 2018). Oil absorption capacity is an important property in food product development because it imparts flavour and mouth feel to foods (Eke-Ejiofor, 2012).

Bulk density indicates how tightly packed the cookies are. Sample A has the highest bulk density at 3.00 g/ml, while Samples B and D have the lowest at 1.50 g/ml. Lower bulk density suggests that the cookies are less dense and may be more tender and crumbly (Rincón *et al.*, 2017).

The foaming capacity of the samples ranged from 0.00 to 7.14%. Sample A (100% plantain flour) had the highest value for foaming capacity (7.14%), this may be due to the fact that plantain flour contain a good array of surface active protein that were able to contribute to foam formation. The foaming stability of the samples followed the same pattern with foaming capacity. Foaming capacity is relevant in applications where aeration is important, such as in cake and muffin production (Adebiyi *et al*., 2016).

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Table 1: Functional Properties of Cookies Produced from Composite flour enriched with Groundnut Paste

Samples	WAC (%)	OAC (%)	Foaming Capacity (%)	Bulk Density (g/ml)	Foam Stability (%)	Swelling Capacity (%)
A	310.0±0.05[a]	120.0±0.05[b]	7.14±0.05[a]	3.00±0.05[a]	4.64±0.05[a]	3.30±0.10[b]
B	200.0±0.01[d]	40.0±0.02[e]	3.70±0.02[b]	1.50±0.12[c]	1.48±0.40[c]	5.20±0.05[a]
C	250.0±0.02[c]	150.0±0.10[c]	0.00±0.00[d]	1.00±0.10[d]	0.00±0.00[d]	2.70±0.01[c]
D	200.0±0.01[d]	100.0±0.05[d]	3.85±0.02[b]	1.50±0.05[c]	2.30±0.05[b]	1.90±0.15[d]
E	280.0±0.01[b]	180.0±0.15[a]	3.57±0.02[c]	2.50±0.02[b]	1.42±0.02[c]	2.90±0.10[c]

Data was presented as mean ± standard deviation (S.D). Mean with different superscript along the same column are significantly different (P<0.05)

Keys

A: 100%plantain flour

B: 90% plantain flour, 5%wheat flour, 5% groundnut paste

C: 80% plantain flour, 5%wheat flour, 15% groundnut paste

D: 70% plantain flour, 10%wheat flour, 20% groundnut paste

E: 60% plantain flour, 15%wheat flour, 25% groundnut paste

3.2 Discussion of Physical Properties of Cookies

The height, thickness, diameter and the spread ratio value ranged between 8.20-12.97cm, 0.63-0.90cm, 0.12-4.83cm, and 0.17-7.27 respectively. Sample E had the highest spread ratio. The spread ratio of cookies is influenced by the dough's viscosity; doughs with lower viscosity allow cookies to spread more quickly during baking. (Miller *et al.*, 2007). Higher spread ratio are desirable in cookies and reduction in spread ratio has been attributed to the hydrophilic nature of flours used in cookie production (Okpala *et al.*, 2013). Sample A (100% plantain) had the highest height of 12.97cm among the experimental samples and increase in wheat and groundnut paste proportion appeared to reduce the height of cookies. The diameter of cookies ranged 0.12-4.83cm, this range was higher than 4.03cm obtained for plantain cookies except sample D (70% plantain, 10% wheat flour and 20% groundnut paste). In respect of thickness, the thickness of all the experimental cookies (0.63-0.90cm) were lower than that of the control plantain cookies.

Table 2: Physical Properties of the Cookies

Samples	Height (cm)	Thickness (cm)	Diameter (cm)	Spread ratio
A	12.97±0.11[a]	0.90±0.15[a]	4.83±0.03[a]	5.37±0.14[c]
B	10.97±1.05[c]	0.79±0.01[b]	4.83±0.01[a]	6.11±0.02[b]
C	11.20±2.01[b]	0.78±0.16[b]	4.82±0.02[a]	6.21±0.32[b]
D	10.70±0.02[c]	0.74±1.01[bc]	0.12±0.01[c]	0.17±0.00[d]
E	8.20±0.01[d]	0.63±1.43[c]	4.58±0.02[b]	7.27±0.21[a]

Data was presented as mean ± standard deviation (S.D). Mean with different superscript along the same column are significantly different (P<0.05)

Keys
A: 100%plantain flour
B: 90% plantain flour, 5%wheat flour, 5% groundnut paste
C: 80% plantain flour, 5%wheat flour, 15% groundnut paste
D: 70% plantain flour, 10%wheat flour, 20% groundnut paste
E: 60% plantain flour, 15%wheat flour, 25% groundnut paste

4.0 CONCLUSION

The result of the study revealed that plantain-wheat composite flour blends enriched with groundnut paste exhibit diverse functional properties, making them suitable for various food formulations and the physical attributes of the cookies can enhance their appeal to consumers. Further research should explore the potential of this composite flour blend in the development of other food products.

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