Production and Evaluation of Ginger Spiced Cookies from Wheat-Plantain Composite Flour.

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ABSTRACT

The baking potentials of flour blends from unripe plantain and wheat flour in varying proportions were evaluated. Samples were coded as follows: Control WG1 represented 100% wheat flour; WPG2, 90% wheat flour,10% plantain flour; WPG3, 80% wheat flour, 20% plantain; and WPG4, 70% wheat flour, 30% plantain flour. The peak viscosity, trough, final viscosity and setback values of composite blends were higher than that of the control containing 100% wheat flour. The protein, fat, ash, and crude fiber content of plantain cookies were significantly higher ($p<0.05$) than the control.

The appearance of the composite cookies were significantly different and higher than that of the control at ($p<0.05$). The mean value (7.30) obtained for WPG2 was higher than that of the control for overall acceptability of composite cookies. The taste of composite cookies WPG2 (6.40), WPG (6.50), WPG4 (5.90) were higher than the control. The crude protein of the control was higher than that of composite cookies. The swelling capacity of WPG2 with mean value of 21.51% was observed to be higher than that of the control. Bulk density of the control WG1 (1.40g/mL) was higher than that of the composite cookies. Values obtained for functional properties of the control were higher than that of composite flours used.

(Keywords: plantain flour, composite flour, nutritional analysis)

INTRODUCTION

Cookies are confectionary products dried to a low moisture content (Okaka, 2009) compared to biscuits. Cookies tend to be larger with a softer chewier texture (IFIS, 2009). Cookies are consumed extensively all over the world as a snack food on a large scale in developing countries where protein and caloric malnutrition are prevalent (Chinma and Gernah, 2007). With the increase advocacy on the consumption of functional foods by world nutrition bodies due to different health problems related to food consumption such as celiac diseases (life-long tolerance to wheat gluten, characterized by inflammation of the proximal small intestine), diabetes and coronary heart diseases, recent World Health Organization (WHO) recommendations to reduce the overall consumption of sugars and food that promote high glucose responses (WHO/FAO, 2003).

A current trend in nutrition is the consumption of low carbohydrate diets, including slowly digested food products as well as increased intake of functional foods (Hurs and Martins, 2005). Food professionals and industries are faced with the challenges of producing foods containing functional ingredients in order to meet the nutritional requirements of individuals with health challenges. Cookies can serve as vehicle for delivering important nutrients if made readily available to the population (Chinma and Gernah, 2007).

Plantain contains functional ingredients principally those with high dietary fiber in which when present in human diets lowers serum cholesterol, reduces the risk of heart attack, colon cancer, obesity, blood pressure, appendicitis and many other diseases (Rehianan *et al*, 2004). On the other hand, resistant starch is also present in plantain and it assists in preventing and managing pre-diabetes and type 2-diabetes (Jideani and Jideani, 2011). Resistant starches have interesting functional properties for use in food such as formation of products with high fiber content and low volume with improved sensory properties such as texture and appearance when compared to products rich in traditional fiber (Nugent, 2005).

There is need to develop cookies containing functional ingredients with high nutritional quality. Unripe plantain is rich in dietary fiber (8.8%) and resistant starch (16.2%), and micronutrients which help to reduce the sugar level and low protein and fat (Ayodele and Erema, 2011).

Ginger (*Zingiber officinale* Roscoe) is a root or an underground stem (rhizome) known to contain gingerols (oleoresin) with several health benefits. It reduces the risk of colon cancer, obesity, diabetes, cardiovascular diseases, cold related-diseases and arthritis (Bailey-Shaw *et al*. 2008, Young *et al*. 2005 and Bliddal *et al*. 2000).

Considering the health benefits of wheat, unripe plantain and ginger powder, their incorporation as composite blends in the preparation of cookies may enhance nutritional and health status of consumers. Several studies have reported the use of wheat based composite flour in (Ajanaku *et al.* 2011; Kamaljit *et al*. 2010; Nasir *et al*. 2010; Onoja *et al.* 2010; Giani *et al*. 2005; Mc Watters *et al.* 2003; Shrestha and Noomhorm, 2002).

JUSTIFICATION

Several cookies products in the country are imported and costly and their consumption increasing. There is need for sustainable development by increasing use of our local agricultural products and reducing pressure on the nation's economy and saving scarce foreign resources spent on importation. Local Industries are trying to be innovative by producing food products using functional ingredients, in order to meet nutritional requirements of Nigeria's rapidly growing population.

This study aims at producing crispy cookies with required nutritional and quality standards that can conform to the consumer's acceptability from blends of wheat, plantain and ginger. Organoleptic properties and shelf stability of the cookies produced would be compared to cookies presently on the market.

MATERIALS AND METHOD

Raw Materials

The raw materials used include: wheat flour (Nigerian Eagle Flour Mills, Ibadan), shortening (Simas margarine PT Initiboga. Jakarta, Indonesia), salt, sugar (Dangote, Nig. Ltd), EDC 2000 obtained from Yaba market in Lagos, and ginger (purchased from Oyingbo market, Lagos, Nigeria).

Apparatus and Equipment Used

Pipette, measuring cylinder, knife, milling machine, tray, bowl, mixer, kneading machine, oven, and baking pans were obtained from the Department of Food Technology, Yaba College of Technology, Yaba, Lagos State, Nigeria.

METHODS

Flowchart of Plantain Flour

Plantain fingers were washed, peeled, and sliced into thin slices of about 5mm thickness using a slicer. The slices were soaked in 1.25% sodium metabisulphite solution, for 5 minutes and steam blanched for another 5 minutes to inactivate polyphenol oxidase (PPO) as reported by (Olaoye et al. 2006) with slight modifications.

The pulp was drained and dried in an oven at 60^{o}c for 24 hours. The dried plantain slices were milled using an attrition mill at the department of Food Technology, Yaba College of Technology, Yaba, Lagos State, Nigeria. The flour was then sieved through a 0.25mm aperture sieve and packaged in low density polyethylene bags.

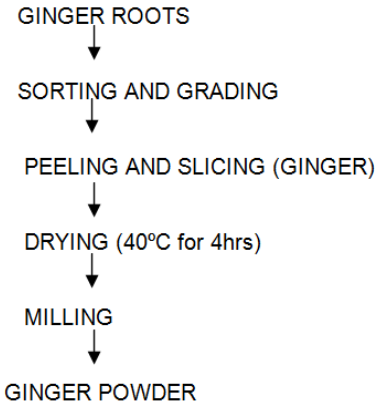

Figure 1: Flow Chart for Ginger Powder
Source: Modified method of AACC. (2005).

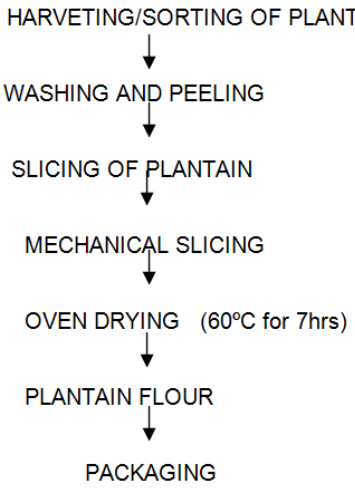

Figure 2: Flow Chart for the Production of High Quality Plantain Flour in Nigeria.
Source: Modified method of Olaoye *et al.,* 2006.

Table 1: Recipe for Dough Formation

Material Composition	Amount
Flour	100g (Wheat and Plantain)
Egg	52g
Sugar	15g
Salt	1g
Water	25g
Milk	125g
Ginger	10g
Vegetable shortening	50g

PREPARATION OF VARIOUS BLENDS

Table 2: Flour Blends of Wheat and Plantain Flours were Prepared in the Following Proportion.

Code	Wheat	Plantain	Ginger Powder
A	100%	0%	3g
B	90%	10%	3g
C	80%	20%	3g
D	70%	30%	3g

FORMULATION OF COOKIES

50g of weighed vegetable shortening was added to the 100% wheat flour or composite blends and mixed until a coarse texture was obtained. The other ingredients were added, followed by already whisked egg. All these were mixed thoroughly to obtain dough. The dough was placed on a clean table, rolled and cut out into required shapes, baked in an oven at 180^{o}C for 30 mins (Kiin-Kabari, 2013).

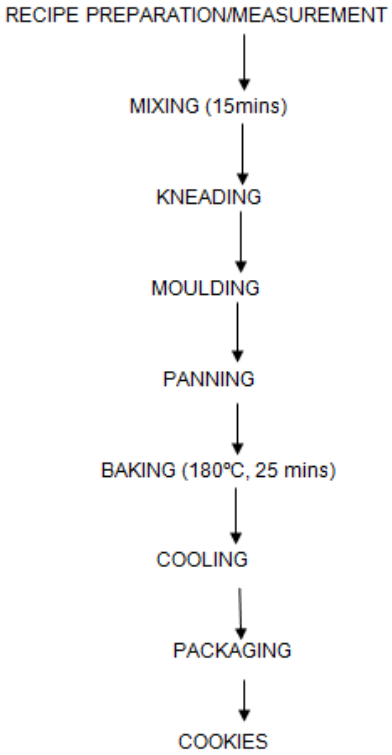

Figure 3: A Modified Flow Chart for Cookies Production.
Source: Modified method of AACC. (2000).

RESULTS AND DISCUSSION

Table 3 shows the results of the proximate analysis of wheat plantain cookies spiced with ginger powder. The table further shows the concentration of moisture content across the four (4) samples (WG1-WPG2) used for this study. Moisture in sample WG1 was 29.28% and higher than that of values obtained from other samples.

The least moisture content was obtained in sample WPG4 14.5%. Same values were obtained for ash content in samples WGP2 and WPG3 with an average value of 2.67. Fat content in sample WPG4 10.08% was higher than that obtained in samples WG1, WPG2, and WPG3, respectively. The table showed that samples WPG2 and WPG3 had the same ash content with equal mean value of 9.30.

Table 3 shows the percentage concentration of fiber in wheat plantain cookies spiced with ginger powder. Crude fiber in sample WPG4 of 5.24% is higher than the other three (3) samples. However, it was equally observed that the lowest fiber concentration was found with sample WPG1 with an average mean of 3.22 ($p<0.05$).

The highest percentage of protein was observed in sample WPG4 with a mean of 14.35. WG1 however had the lowest concentration of protein relative to three (3) other samples. Addition of wheat flour to unripe plantain flour and ginger increased moisture, protein and ash content of the experimental samples while fat and carbohydrate contents decreased respectively.

Cookies from composite blends had higher values for protein, ash, fat and crude fiber contents than cookies made from 100% wheat flour. The moisture content of cookies from composite blends was within recommended values for safe keeping of flour samples (SON, 2007). The increase in protein, ash and crude fiber contents of unripe plantain flour due to wheat flour and ginger powder addition may be attributed to addition effect caused by wheat flour which contained higher amounts of protein, ash and crude fiber. Proximate composition of unripe plantain-wheat flour and ginger powder blends obtained in this study is similar to that reported by Akubor and Ukwuru (2003) for plantain-cowpea flour blends.

Table 2 reveals the pasting characteristics of wheat plantain cookies spiced with ginger powder. The peak value of sample WG1with an average mean value of 454.67 is higher than other samples. It was equally observed from table 3 that sample WPG2 was attributed the highest trough value of 276.00RVU.Pasting temperatures for samples WPG2 75.05ºC is higher than other samples. The peak viscosity, trough, break down, final viscosity, set back value, peak time and temperature values of flour samples are shown, respectively.

Table 3: Proximate Composition of Cookies Spiced with Ginger Powder.

Sample	Moisture Content (%)	Ash (%)	Fat (%)	Crude Fiber (%)	Crude Protein (%)	Carbohydrate (%)
WG1	29.28±09^{a}	0.62±0.08^{c}	9.04±0.05^{c}	3.22±0.01^{d}	9.30±0.01^{a}	53.81±0.09^{c}
WPG2	28.26±0.6^{b}	1.37±0.17^{b}	9.30±0.01^{b}	4.67±0.02^{c}	4.10±0.01^{d}	52.24±0.14^{d}
WPG3	20.21±0.5c	1.37±0.17^{b}	9.30±0.01^{b}	4.88±0.01^{b}	4.17±0.02^{c}	59.06±0.70^{b}
WPG4	14.45±0.5^{d}	2.67±0.33^{a}	10.08±0.03^{a}	5.24±0.04^{a}	4.35±0.06^{b}	63.21±0.43^{a}

WGI=Wheat flour/Ginger powder (100:0:3)
WPG2=Wheat flour/plantain flour / ginger (90:10:3)
WPG3=Wheat flour/plantain/ginger (80:20:3)
WPG4=Wheat flour/plantain/ginger (70:30:3)

Table 4: Pasting Properties of Cookies Spiced with Ginger Powder.

Sample	Peak (RVU)	Trough (RVU)	Break down (RVU)	Time (Min)	Temp. (ºC)	Setback (RVU)	Final (RVU)
WG1	454.67±0.1[a]	208.75±1.1[c]	245.92±1.2[a]	4.50±0.1[b]	75.00±0.2[a]	62.13±0.6[c]	270.80±0.6[d]
WPG2	419.85±0.4[b]	243.15±1.0[b]	176.70±1.0[b]	4.65±0.1[b]	74.07±0.3[b]	66.00±0.5[a]	309.75±1.0[b]
WPG3	406.60±1.0[c]	276.00±1.2[a]	130.05±1.1[d]	5.16±0.1[a]	75.07±0.3[a]	66.25±1.0[a]	342.50±1.0[a]
WPG4	408.32±0.7[c]	243.00±1.0[b]	147.00±0.1[c]	4.38±0.1[c]	72.01±0.3[c]	65.22±1.0[b]	307.61±0.9[c]

WGI=Wheat flour/Ginger powder (100:0:3)
WPG2=Wheat flour/plantain flour/ginger (90:10:3)
WPG3=Wheat flour/plantain/ginger (80:20:3)
WPG4=Wheat flour/plantain/ginger (70:30:3)

The RVU properties of flour samples showed that unripe plantain-wheat flour blends had higher peak viscosity, trough, final viscosity and setback value than wheat flour. Protein forms complexes with the starch granule surface preventing the release of exudates and lowering the viscosity. The increase in peak viscosity, trough, break down, final viscosity and set back value among composite blends with increasing level of wheat flour could be attributed to reduction in amylose content in blends since unripe plantain flour contain higher amylose content than wheat flour. Low amylose content has been reported to be associated with a higher peak viscosity and a lower pasting temperature (Zaidul *et al*. 2007).

Bulk density in sample WPG3 and WPG4 are equal with an average value of 1.2 g/mL as shown in Table 5. Sample WG1 and WPG4 had the highest value of 1.40 g/mL are equal with an average mean of 1.24. The swelling capacity for sample WPG2 was higher than any other sample across the eight samples. However, the table showed the disparity in the mean value of the swelling capacity across the other three samples.

The increase in weight of composite cookies due to addition of wheat flour could be attributed to high bulk density of wheat flour than that of unripe plantain flour. The higher bulk density of unripe plantain-wheat flour blends could also account for higher weight of composite cookies than 100% wheat cookies. There was an increase in protein content of composite biscuits with increased level of wheat flour addition. According to (Nasir *et al*. 2010), the increased number of hydrophilic sites available due to increased protein content competes for the limited free water in cookies dough.

Table 6 above shows results of sensory evaluation of wheat plantain cookies spiced with ginger powder. Sample WPG3 was the most acceptable in terms aroma and taste with mean value of 6.40 and 6.50 while samples WPG3 was most acceptable in terms of aroma with mean value of 6.40. Sample WPG2 had the highest mean value 7.70 in terms of overall acceptability on a 9 point hedonic scale. Hence, it was the most acceptable out of all the samples.

Though there were no significant difference in texture between 100% wheat flour and composite cookies, the 100% wheat flour cookies had higher textural score than the composite cookies. This could be attributed to the presence of gluten that resulted in formation of elastic dough which was had during handling, resulting to cookies with higher texture after baking than non-wheat composite cookies.

From overall acceptability scores, it was concluded that wheat plantain flour and ginger could be incorporated up to 70:30:3 ratios in the preparation of cookies without affecting the sensory properties of the cookies. There were significant ($p \geq 0.05$) difference in aroma, color, taste, texture and overall acceptability of cookies prepared from 100% wheat flour and the experimental samples. This result implies that the evaluated sensory properties of 100% wheat cookies are different from the experimental samples. The result on the color of cookies showed there was significant difference between the experimental samples and the control sample. Dark color of the wheat flour cookies (control) have been reported by several authors (Singh *et al.* 2000; Akhtar *et al*. 2008; Serrem *et al*., 2011).

Table 5: Functional properties of wheat plantain cookies spiced with ginger powder.

Sample	Bulk density (g/mL)	Swelling capacity (%)
WG I	1.40±0.11[a]	1.46±0.33[d]
WPG2	1.26±0.53[b]	2.51±0.26[a]
WPG3	1.24±0.20[b]	1.83±0.07[c]
WPG4	1.24±0.20[b]	2.27±0.01[b]

WGI=Wheat flour/Ginger powder (100:0:3)
WPG2=Wheat flour/plantain flour / ginger (90:10:3)
WPG3=Wheat flour/plantain/ginger (80:20:3)
WPG4=Wheat flour/plantain/ginger (70:30:3)

Table 6: Sensory Evaluation of Wheat Plantain Cookies Spiced with Ginger Powder.

Samples	Appearance /Color	Taste	Aroma/Smell	Texture	Overall acceptability	P-Value
WG1	5.60±2.37[c]	5.10±2.84[d]	4.70±2.49[d]	5.70±2.49[c]	6.20±2.52[d]	0.087
WPG2	7.10±1.37[b]	6.40±1.89[a]	6.50±1.35[a]	7.30±1.16[a]	7.70±1.34[a]	0.093
WPG3	7.40±1.26[a]	6.50±1.43[a]	6.40±0.84[b]	7.20±1.62[b]	7.30±1.42[b]	0.021
WPG4	6.80±1.62[c]	5.90±2.33[c]	5.70±2.05[c]	5.60±2.11[d]	6.50±2.12[c]	0.051

WGI=Wheat flour/Ginger powder (100:0:3)
WPG2=Wheat flour/plantain flour / ginger(90:10:3)
WPG3=Wheat flour/plantain/ginger (80:20:3)
WPG4=Wheat flour/plantain/ginger (70:30:3)

The brownish cookies appearance could be directly related to the increase in fiber content (Hu *et al.,* 2007). Moreover browning of the cookies could also occur due to caramelization and maillard reactions, as the protein contributed by ginger and plantain flour must have reacted with sugar during the baking process (Dhingra and Jood, 2001; Mohsen *et al*. 2009).

CONCLUSION

The use of unripe plantain and composite flour in the production of cookies improved the nutritional and sensory qualities of the samples without adversely affecting most baking characteristics. Cookies with ginger and wheat-plantain flour were found to be nutritionally superior (have higher protein, fat, and crude fiber content) to whole wheat cookies. However, the scores for organoleptic attributes like taste, aroma, texture (mouth feel), except for color were generally inferior to that of wheat cookies. Therefore, the composite wheat plantain cookies had better overall acceptability scores than the wheat cookies.

RECOMMENDATIONS

Cookies prepared from composite flour could help in combating protein–energy malnutrition; they also have potential to be of immense benefits to patients with medical conditions such as celiac, hypertension, diabetes, and obesity considering their poor starch and protein digestibility and relative high crude fiber. Matured green unripe plantain can consequently be used in the production of acceptable cookies to reduce cost of importation of wheat flour and to promote sustainable development. Spices incorporated in the production of cookies could promote increased its shelf life, flavor enhancement, improved nutritional content and enhanced purchase intent.

Further studies could be carried out on the consumer acceptability of cookies made using other spices different from ginger powder and to determine the mineral content of the product (cookies) and its bioavailability. Wheat unripe plantain flour composite cookies serve as functional food because of their high fiber content.

Good consumer education and public enlightenment on the nutritional benefits of the plantain and ginger-supplemented functional foods should be encouraged to promote acceptability and health benefits of plantain and ginger-enriched cookies. There is need to commission studies to optimize mixing and baking conditions in order to improve acceptability of composite cookies. For biscuits and cookies production, moisture removal and color development are main goals. It is recommended that the dough temperature should be adequately controlled so that the color of the final product can have good aesthetic appeal.

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