Nutrient Quality Evaluation of Cookies produced from Blends of Wheat, Soybean and Unripe Plantain Flours

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ABSTRACT
The potential use of composite flours for the production of bakery products to increase and improve the protein content is one of the areas of research interest nowadays. In this study, suitability of wheat, soybean and unripe plantain composite flour blends was investigated for the development of cookies. Six blends of flour recipes were prepared by mixing different proportions of wheat flour (WF), soybean flour (SF) and unripe plantain flour (PF) and 100% WF served as control to produce cookies. The flour ratios were; A= (100 % wheat flour/control), B= (90:5:5), C= (80:15:5), D= (70:20:10), E= (60:25:15) and F= (50:30:20). The proximate composition varied from 7.48 - 14.01 %, 7.17 - 17.21 %, 1.65 – 5.22 %, 2.67 – 5.18 %, 1.55 – 5.88 % and 57.30 - 72.02 **%**, for moisture, protein, fat, crude fibre, ash and carbohydrate contents, respectively. The mineral contents ranged from 87.82 to 143.59 mg/100g, 44.35 to 78.15 mg/100g, 1.23-4.15 mg/100g, 1.27 to 2.18 mg/100g, 87.67 to 112.27 mg/100g and 67.98 to 157.22 mg/100g for potassium, calcium, iron, zinc and magnesium, respectively. The result of the mineral analysis revealed that the calcium and iron were the predominant mineral elements in the cookies samples and the mineral composition increased with level of plantain addition. This showed the viability of producing nutritious cookies with desirable nutritional qualities from wheat, soybean and unripe plantain.

Keywords: Cookies, wheat, soybean, plantain, quality evaluation

Introduction
Cookies have been defined as snacks that are produced from unpalatable dough which when baked in an oven is transformed into an appetizing product. Cookies are traditionally produced from wheat flour which possesses gluten that is known for its unique viscoelastic characteristics which is desirable in the bakery industry. Cookies are a group of foods which has long shelf life, generally accepted by all age groups and are available almost everywhere (Olaoye *et al.,* 2007). The principal ingredients in the manufacturing of cookie include flour, fat, sugar, milk, salt, flavouring agent, egg, baking powder, butter, etc (Okpala and Okoli, 2011). Wheat (*Triticum aestivum*) is one of the most useful and valuable crops grown around the world and it is considered as almost first among cereals largely due to the fact that its grain contains protein having unique chemical and physical properties including other vital nutrients (Ikhtiar and Alam, 2007). Wheat is the ideal flour suitable for baking. The high level of its utilization has resulted in an overdependence on wheat flour for baked goods especially in developing countries like Nigeria. Soy bean (*Glycine max*) is an edible legume highly famed for being nutritious; as they are rich in protein, calcium, fiber, iron, magnesium, and other enriching vitamins and minerals (Adelakun *et al*., 2013). It can be cooked, fermented, dried, and converted into products like milk, flour, and tofu. Soy beans contain significant amounts of phytic acid, dietary minerals and B vitamins. Soy vegetable oil, used in food and industrial applications from soybean crop. Plantain is one of the important tropical crops that have high content of resistant starch. It belongs to the family *Musaceae* and the genus *Musa. Musa paradisiaca*, also known as plantain (English), '*Ogede agbagba*' (Yoruba), '*Ayaba*' (Hausa) and '*Ogadejioke*' (Igbo), is a tropical plant that is native to India (Awoyale *et al*., 2013). The plant consists of long, overlapping leafstalks and bears a stem which is 1.22 to 6.10m high (Oladiji *et al*., 2010), with a life span of about 15 years. Plantain is very rich both in macro and micronutrients. Therefore, the addition of soybean and unripe plantain which are rich in lysine and tryptophan was meant to enhance the nutritional capacity of the composite flour. The objective of this work was to determine the nutritional composition of cookies from wheat, soybean and unripe plantain flours.

MATERIALS AND METHODS

Procurement of Materials

Wheat flour, soy beans, unripe plantain and other major ingredients like flavour, milk, eggs, salt, margarine, sugar and baking powder used were purchased from Ogbete main market Enugu, Enugu State, Nigeria.
The equipment and reagents used were obtained from the Department of Food Science, Institute of Management and Technology, IMT Enugu, Enugu State.

Production of Soybean and unripe plantain flours

The boiled soybean flour was prepared according to the method of Makinde and Ladipo (2012). Soybean seeds were sorted, washed and soaked in water for 6 h. It was boiled in pressure cooker for 5 min, dehulled and dried in a locally fabricated cabinet dryer at 50 °C for 48 h, then milled into flour using the locally fabricated attrition mill and sieved through a 435 micron mesh sieve to produce soybean flour that was stored in a dry air tight container. The plantain flour was prepared according to the method described by Chinmah *et al.* (2007). One kilogramme (1kg) of mature unripe plantain fruits were thoroughly cleaned and peeled manually with a kitchen knife. The slices were rinsed and placed into a stainless pot and blanched with 3 litres of potable water at 85^{o} C for 20 min on a hot plate. The blanched slices were drained, rinsed and spread on the trays and dried in a hot air oven (Model Gallenkamp 300 Plus England) at 60 ^{o}C for 18 h with occasional stirring of the slices at intervals of 30 min to ensure uniform drying. The dried slices were milled using an attrition mill (Model Globe P44, China) and sieved through a 500 micron mesh-sieve. The flour produced was packaged in an airtight plastic container, labeled and stored in a refrigerator until needed for further use.

Production of cookies

Six blends of flour recipe were prepared by mixing different proportions of wheat flour (WF), soybean flour (SF) and unripe plantain flour (PF) and 100% WF served as control. The flour ratios were; A= (100 % wheat flour/control), B= (90:5:5), C= (80:15:5), D= (70:20:10), E= (60:25:15) and F= (50:30:20). Cookies were prepared using the method described by Ikechukwu *et al.* (2017). The ingredients (wheat flour, soybean flour and unripe plantain flour) were measured into a bowl. All the samples of cookies contained 30g sugar, 25g fat, 1.5g baking powder, 4g vanilla flavor, 0.5g salt 30g whole egg and small quantity of water. Using the rubbing method, fat, milk and salt were added and rubbed for 30 min. In a separate bowl, egg and water was mixed and added to the flour-based mixture, then kneaded to make dough. The dough was rolled and flattened into a uniform thickness of about 3.5 mm before cutting out to shapes using biscuit cutter. The cut-out dough was baked in the oven at 150°C for 10-15 min. After baking, the cookies were cooled to room temperature, packed in low density polyethylene (LDPE) bags and sealed in a plastic transparent container.

Analyses

The proximate composition of the cookies samples were determined according to the method described by AOAC (2010) for moisture, ash, crude fibre, protein, crude fat and carbohydrate by difference. Calcium, potassium, magnesium, iron and zinc were determine using the dry-ash techniques according to method described by Ikuomola *et al.* (2017). The data obtained were statistically analysed using the Statistical Analysis Software (SAS) package (version 11 of SAS Institute, Inc.).

RESULTS AND DISCUSSIONS

Table 1: Proximate composition of cookies samples

Sample	Parameters					
	Moisture Content	Ash	Crude Fibre	Fat	Crude Protein	Carbohydrate
A	7.48^{f}±0.007	1.55^{f}±0.014	2.67^{f}±0.007	1.65^{f}±0.014	7.17^{f}±0.007	79.63^{a}±0.007
B	9.53^{e}±0.007	2.55^{e}±0.007	4.74^{e}±0.014	4.73^{e}±0.007	10.42^{e}±0.530	68.03^{b}±0.014
C	11.67^{d}±0.014	3.61^{d}±0.007	4.88^{d}±0.007	4.94^{d}±0.007	12.67^{d}±0.007	62.23^{c}±0.014
D	13.14^{c}±0.007	3.74^{c}±0.007	5.01^{c}±0.007	5.09^{c}±0.007	14.24^{c}±0.007	58.78^{d}±0.007

E	13.88^{b}±0.007	4.42^{b}±0.007	5.11^{b}±0.007	5.17^{b}±0.007	15.13^{b}±0.007	56.29^{e}±0.007
F	14.01^{a}±0.007	5.88^{a}±0.007	5.18^{a}±0.007	5.22^{a}±0.007	17.21^{a}±0.007	52.50^{f}±0.007

Values are mean ± standard deviation of duplicate determinations. Means in the same column with different superscripts are significantly different ($p < 0.05$). A = cookies made with 100% Wheat flour (Control), B = cookies made with 90% Wheat flour + 5% soybean, 5% unripe plantain flour, C = cookies made with 80% Wheat flour + 15% soybean, 5% unripe plantain flour, D = cookies made with 70% Wheat flour + 20% soybean, 10% unripe plantain flour, E = cookies made with 60% Wheat flour + 25% soybean, 15% unripe plantain flour, F = cookies made with 50% Wheat flour + 30% soybean, 20% unripe plantain flour.

The results of the proximate analysis of the cookies produced from whole wheat, soybean and corn flour mixes are shown in Table 1. The moisture contents of the cookies ranged from 7.48 to 14.01%. The moisture level increased as the amount of soybean and plantain flours substituted increased. Sample A (control) had the least value of 7.48 % while sample F substituted with 30% soybean and 20% unripe plantain flours had the highest value of 14.01%. The moisture content has been used as a measure of stability and susceptibility to microbial contamination. Moisture content is very essential for shelf-life maintenance and also determine the way food may be processed (Akinsanmi *et al.*, 2015). There was increased in protein content of the cookies as the soybean flour substitution level increased. The protein content ranged from 7.17 to 17.21%. Sample F substituted with 30% soybean and 20% unripe plantain flours had the highest value of 17.21% while sample A (control) had the lowest value of 7.48%. The value obtained in this research work is in accordance with a range of 14.65 to 18.31% reported by Tanko *et al.* (2020), in the quality characteristics of biscuits produced from composite flour of sweet potato and cashew nut flour blends. The highest protein was obtained with the highest substitution level of soybean flour which might be due to the protein content of soybean flour. The fat content of the cookies ranged from 1.65 to 5.22% in the cookies samples. Sample F had the highest value of 5.22% while sample A had the lowest value of 1.65%. The results may be due to the variations of the samples and the processing method adopted. Soybean (an oil seed) from which the soy-flour was produced must have contributed most of its oil content to the product. The high oil content of the cookies will affect the shelf stability (Potter and Hotchkiss, 2006). The crude fibre content of the cookies increased in the range of 2.67 to 5.18% as the percentage of soybean and unripe plantain flour mixes increased. Sample F had the highest value of 5.18% while sample A had the lowest value of 1.55%. Fibre is essential in human diet as it improves the stool bulk by acting as a vehicle for faecal fluid. It improves the health of the gastro-intestinal system and metabolic system in human (Atobatele and Afolabi, 2016). The increased fibre and lower carbohydrate contents of cookies have several health benefits, as it will aid digestion in the colon and reduce constipation often associated with products from refined grain flours (Elleuch *et al.*, 2011; Slavin, 2005). The crude fibre content of the cookies was within the recommended range of not more than 6 g dietary fibre and other non-absorbable carbohydrates per 100 g dry matter (Potter and Hotchkiss, 2006). The ash content of the cookies increased from 1.55 to 5.88% as the substitution levels increased. Sample F had the highest value of 5.88% while sample A had the lowest value of 1.55%. Atobatele and Afolabi (2016) also observed that there was an increase in the ash content of cookies with increasing level of soy-flour and plantain in the flour blends. Ash content is a representation of mineral content, samples with high ash content are expected to have a relatively high mineral content (Olapade and Adeyemo, 2014). The carbohydrate content of the cookies ranged from 52.50 to 79.63%. Sample A (control) had the highest carbohydrate value of 79.63% while sample F had the lowest carbohydrate value of 52.50%. This implies that the snacks are good sources of energy needed for normal body metabolism. The significant variation ($p<0.05$) in carbohydrate content may be attributed to alterations in other constituents. The cookies can be used as energy-based snacks (Atobatele and Afolabi, 2014).

Table 2: Mineral composition of cookies samples

Samples	Potassium	Calcium	Iron	Zinc	Phosphorus	Magnesium
A	143.59^{a}±0.03	44.35^{f}±0.01	1.23^{f}±0.02	1.27^{f}±0.01	87.67^{f}±0.02	157.22^{a}±0.02
B	136.87^{b}±2.35	48.27^{e}±0.08	1.60^{e}±0.04	1.33^{e}±0.03	90.39^{e}±0.01	132.63^{b}±0.01

C	120.97^{c}±0.64	52.87^{d}±0.11	2.26^{d}±0.06	1.43^{d}±0.10	96.32^{d}±0.01	118.04^{c}±0.01
D	104.38^{d}±0.00	58.65^{c}±0.02	3.39^{c}±0.01	1.60^{c}±0.02	98.67^{c}±0.00	104.58^{d}±0.07
E	92.78^{b}e0.05	64.57^{b}±0.00	3.74^{b}±0.07	1.97^{b}±0.11	105.48^{b}±0.03	85.22^{e}±0.03
F	87.82^{f}±0.54	78.15^{a}±0.04	4.15^{a}±0.05	2.18^{a}±0.07	112.27^{a}±0.01	67.98^{f}±0.06

Values are mean ± standard deviation of duplicate determinations. Means in the same column with different superscripts are significantly different ($p < 0.05$). A = cookies made with 100% Wheat flour (Control), B = cookies made with 90% Wheat flour + 5% soybean, 5% unripe plantain flour, C = cookies made with 80% Wheat flour + 15% soybean, 5% unripe plantain flour, D = cookies made with 70% Wheat flour + 20% soybean, 10% unripe plantain flour, E = cookies made with 60% Wheat flour + 25% soybean, 15% unripe plantain flour, F = cookies made with 50% Wheat flour + 30% soybean, 20% unripe plantain flour.

Mineral composition of the cookies

The results of mineral composition of cookies samples are as shown in Table 2. The values ranged from 87.82 to 143.59mg/100g, 44.35 to 78.15mg/100g, 1.23-4.15mg/100g, 1.27 to 2.18mg/100g, 87.67 to 112.27mg/100g and 67.98 to 157.22mg/100g for potassium, calcium, iron, zinc, phosphorus and magnesium, respectively. The increase in mineral content of cookies could be due to increase in substitution levels of soybean and unripe plantain flours compared to whole wheat flour. Soybean and unripe plantain flour contain high levels of important minerals such as potassium, phosphorus, zinc, calcium and iron (Watson, 1997). The mineral content of the cookies increased as the soybean and unripe plantain flours substitution increased for all the minerals analyzed. Calcium content increased significantly with increase in soybean supplement levels. Other researchers have also reported an increase in calcium content of composites with an increase in soybean supplementation (Adelakun *et al.*, 2013; Bolarinwa *et al.*, 2015). Thus, these flours could be substituted with wheat flour to improve nutritional quality of resultant food products. Minerals are important in the diet because of their various functions in the body.

CONCLUSION

The findings from this study showed that supplementing whole wheat flour with soybean and unripe plantain flour in the cookies production resulted to increase in fat, protein, crude fibre and ash contents of the cookies. The cookies samples also indicated presence of the essential minerals. Hence, incorporation of the flour mixes could eradicate malnutrition among populace in the developing countries.

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