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Quality Evaluation of Cookies Produced from Blends of Sweet Potato and Fermented Soybean Flour

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Abstract**—**The study was conducted to evaluate the quality characteristics of cookies produced from sweet potato-fermented soybean flour. Cookies were subjected to proximate and sensory analysis to determine the acceptability of the product. Protein, fat and ash increased as the proportion of soybean flour increased, ranging from 13.8-21.7, 1.22-5.25 and 2.20-2.57 respectively. The crude fibre content was within the range of 3.08-4.83%. The moisture content of the cookies decreased with increase in soybean flour from 3.42-2.13%. Cookies produced from whole sweet potato flour had the highest moisture content of 3.42% while 30% substitution had the lowest moisture content 2.13%. A nine point hedonic scale was used to evaluate the organoleptic characteristics of the cookies. The sensory analysis indicated that there was no significant difference between the cookies produced even when compared to the control 100% sweet potato cookies. The overall acceptance of the cookies was ranked to 20% soybean flour substitute.

Keywords**—**Cookies, Fermented Soybean, Overall Acceptability, Sweet Potatoes.

I. Introduction

THE consumption of cereal snacks foods, such as biscuits, cookies, wafers and short bread has become very popular in Nigeria especially among children. Biscuits are one of the popular cereals snack foods; apart from bread; consumed in Nigeria. They are ready-to-eat, convenient and inexpensive food products, containing digestive and dietary principle of vital importance. They are nutritive snacks produced from unpalatable dough that is transformed into appetizing product through the application of heat in the oven [19]. In Nigeria, the consumption of ready-to-eat baked products is continually growing and there has been an increase in reliance on imported wheat [2]. Moreover, Nigeria grows staple crops other than wheat such as sweet potato, cassava or yam and cereals that can be used for bakery foods. It would therefore be of economic advantage if wheat flour can be replaced with flour from tubers, legumes and cereals hence reducing the reliance on its importation and thus enhance the industrial utilization of local crops.

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Sweet potato is a large, starchy, sweet-tasting, tuberous root and is an important root vegetable. Besides simple starches, sweet potatoes are rich in complex carbohydrate, dietary fiber, beta carotene (a vitamin A equivalent nutrient), vitamin C and vitamin B6. Sweet potato has a higher B-carotene content than any other root or tuber crop. Despite the name (sweet) it may be a beneficial food for diabetics, as preliminary studies on animals have revealed its help to stabilize blood sugar level and to lower insulin resistance [13].

Soybean is an excellent source of protein (40-45%); hence the seeds are the richest in food value of all plant food consumed in the world [10]. It is also known to be a good source of the trace elements copper, zinc and manganese [6]. It is the only source that contains all essential amino acids. Protein content of soybean is about 2 times that of other pulses, 4 times that of wheat, 6 times that of rice grain and 4 times that of milk. Soybean has 3% lecithin, which is beneficial for brain development [5].

Fermentation remains an effective, inexpensive method for extending the shelf life of foods and increasing their nutritional content. The traditional fermentation process serves several functions, including the enrichment of food substances biologically with protein, essential amino acids, essential fatty acids, vitamin, poly amines, carbohydrates and numerous antioxidants and phytosterols, and increases the quantity, availability, digestibility and assimilation of nutrients in the body. Fermentation process also evolved for the development of taste and aroma, often resulting in enhanced nutrition and detoxification of antinutrient factors [18].

In this study, efforts have been made to fortify sweet potato flour with soybean flour to develop a nutritionally balanced biscuit. At the same time, to find more utilization for sweet potato and soybean in order to encourage the use of indigenous crops and improve Gross domestic product.

The objective of this study was to produce a nutritionally balanced cookie/biscuit from blends of sweet potato flour and fermented soy flour.

II. Materials and Method

All the raw materials were purchased from Oyingbo market in Lagos, Nigeria. Mature soybean seed, sweet potato tuber (yellow variety), margarine, salt, sugar, and eggs.

A. Methods

1. Preparation of Sweet Potato Flour

Sweet potato tubers
↓
Washing
↓
Peeling
↓
Slicing
↓
Washing
↓
Soaking
↓
Draining
↓
Drying
↓
Milling
↓
Sieving
↓
Sweet potato flour

Fig. 1 Flow chart for production of sweet potato flour [8]

2. Preparation of Fermented Soybean Flour

Soybeans
↓
Sorting
↓
Soaking
↓
Fermenting
↓
Drying
↓
Milling
↓
Sieving
↓
Soybean flour

Fig. 2 Flow chart for the processing of fermented soybean flour [20]

III. Biscuit Formulation

A. Composition of Biscuit Formulation

Ingredient
↓
Weighing
↓
Mixing
↓
Kneading/ shaping
↓
Cutting
↓
Baking
↓
Cooling
↓
Packaging
↓
Cookies

Fig. 3 Flow chart for the production of cookies [11]
N.B: Ingredients mixed (flours, fat, sugar, salt, egg, baking powder, water)

TABLE I
Biscuit Formulation [16]

SAMPLE	SPF	SBF
SPI	100	0
SPB	90	10
SPT	80	20
SPR	70	30

IV. Product Analysis

A. Functional Properties of the Composite Flour

1. Water Absorption and Solubility Index

To 1g of the sample, 15ml of distilled water was added in a 25ml centrifuge tube and agitated on a vortex mixer for 2 minutes. It was then centrifuge at 4000rpm revolutions per minutes for 20minutes. The supernatant was decanted and discarded. The adhering drops of water were removed and the tube reweighed again [17].

$$WAC = \frac{\text{Weight tube + sediment - weight of empty tube}}{\text{Weight of sample}}$$

2. Swelling Power

1g of the sample was weighed into 50ml plastic centrifuge tube. 50ml of distilled water was added to the sample and mixed gently. The slurry was heated in a water bath at 60, 70, 80, 90, 100ºC respectively for 10 minutes. The solution was gently shaken during heating to prevent clumping of the starch and the solution will be centrifuge at 3000rpm for 10 minutes. Then the supernatant was decanted and dried to determine the amount of soluble solid and dissolved and was used to calculate the solubility. The weight of the sediment was recorded and moisture content of the sediment gel would be determined [22].

$$\text{Swelling power} = \frac{\text{Weight of the wet mass of seed}}{\text{Weight of dry matter in the gel}}$$

3. Bulk Density

A known amount of samples was weighed into 50mls graduated measuring cylinder. The sample was packed by gently tapping the cylinder on the bench top 10 times from a height of 5cm. T he volume of the sample was recorded [3].

$$\text{Bulk density (g/ml or g/cm3)} = \frac{\text{Weight of sample}}{\text{Volume of sample after tapping}}$$

4. Dispersibility

10g of flour samples was weighed into 100ml measuring cylinder and distilled water was added to reach a volume of 100ml. the set up was stirred vigorously and allowed to settle for 3hrs. The volume of settled particles was recorded and subtracted from 100. The difference was reported as % dispersibility [15].

5. Wettability

1g of the flour sample was dropped from a height 15mm onto the surface of 200cm of distilled water contained in $250cm^3$ at room temperature. The wetting time was regarded as the time required for all the flour to become wetted and penetrate the surface of the still water [7].

B. Proximate Analysis of Cookie Samples

1. Moisture Content Determination

The moisture content was determined as described by AOAC [1]. 2g of the samples was weighed accurately into a weighed dry-cleaned dish with an easily removable lid. The uncovered dish containing the sample with its lid was placed in a well insulated oven at 103ºC for 3 hours. Then it was removed and transferred into desiccators at room temperature to cool. After cooling, the sample was weighed and replaced in the oven for another 1 hour. After this, the dish containing the sample was removed and cooled in a desiccators and re-weighed. The procedure was repeated until a constant weight is obtained. The loss in weight was reported as moisture content and calculated as:

$$\% MC = \frac{M1 - M2}{M1 - M0} \times 100\%$$

where;
Mo = weight of dish and lid (g)
M1 = weight of dish and sample after drying (g)
M2 = weight of dish and sample before drying (g)
M1 – Mo = weight of sample prepared for drying (g)
% dry matter content = 100% moisture content.

2. Ash Content Determination

The ash content is the amount of mineral constituent of a food material as described by AOAC [1]. The crucible was weighed and dried in the oven and cooled in the desiccators, and weighed again. 3g of the grinded sample was weighed in an empty porcelain crucible, which has been place in a muffle furnace and maintained at 550ºC for 45 minutes after which the crucible was then transferred into the desiccators, cooled and weighed. The percentage ash content was determined using this method.

$$\% \text{Ash} = \frac{\text{weight of crucible + ash – weight of empty crucible}}{\text{Weight of sample}} \times 100\%$$

3. Crude Fibre Determination

29g of the sample was weighed into 600ml long beaker. 100ml of hot 1.25% H_2SO_4 was added (heated), boiled and reflux for 30 minutes. It was then filtered through what man filter paper; the beaker was then rinsed with distilled water until the filter becomes neutral.

The residue was then transferred into another beaker and 100ml of 1.25% NaOH would be added. The digestion process was repeated by boiling and refluxed for 30 minutes. It was then filtered, and the beaker rinsed with distilled water. The residue was then washed with distilled water until the filtrate becomes neutral. The residue was then transferred into the oven to dry. After drying, it was then coded in a decanter and weighed (weight A). The sample was then put in the furnace at 600ºC for 6 hours, then cooled and reweighed (weight B). The losses in weight during incineration represent the weight of crude fibre in the sample [1].

$$\% \text{ crude fibre} = \frac{\text{weight A – weight B}}{\text{Sample weight}} \times 100\%$$

4. Protein Content Determination

Protein content was determined as described by AOAC [1]. 1g of the sample was weighed into a digestion flask and 7 kjeidahl tablets were added to it. 20ml of concentrated H_2SO_4 was added and digested for 5 hours until a clear solution was obtained, the digest was then cooled, transferred into 100ml of volumetric flask and made up to mark with distilled water. 20 ml of boric acid was dispensed into conical flask; while 5 drops of the indicator and 75ml of distilled water was added to it. 10ml of the digest was dispensed into Kjeidahl distillation flask.

The conical flask and the distilled flask was fixed in place and 20% NaOH was added through the gas funnel into the digest. The steam exist was closed and the time was taken when the solution of the boric acid and the indicator turned green. The distillation was carried out for 15mins and distillate titrated with 0.05M HCL.

$$\% \text{ total nitrogen} = \frac{14.01 \times (\text{sample titre – blank titre}) \times N}{10 \times \text{sample weight}}$$

5. Fat Determination

The fat content was determined using the method described by AOAC [1]. The sample (10g) was weighed on a chemical balance and wrapped up in a filter paper. It was then placed in the extraction thimble. Fat extraction unit was cleaned, dried in an oven and cooled in the dessicator before weighing. Petroleum ether (25ml) was measured into the flask and the fat extracted with solvent. After extraction, the solvent was evaporated by drying in the oven. The flask and the content was then cooled in a dessicator and weighed. The fat content was calculated as follows:

$$\% \text{ fat content} = \frac{X - Y}{Z}$$

where;
X= weighed of fat + flask
Y= weight of flask
Z= weight of sample

6. Carbohydrate Determination

Total carbohydrate was determined by differences between 100 and total sum of the percentage of fat, moisture, ash, crude fiber and protein content [10].

7. Energy Value

The energy value was determined using bomb calorimeter. The sample was introduced into the bomb calorimeter and burnt in excess oxygen at pressure of 25atm. Rise in temperature due to burning was shown in the increasing deflection of galvanometer reading. Energy value was also estimated using the Atwater factor.

C. Sensory Evaluation

The consumer acceptability test was determined using the method described by [12]. The test was carried out using thirty six panelists consisting of mainly students and few members of staff of the Yaba College of Technology. The samples were presented in white side plate coded SPI, SPB, SPT and SPR and were done individually in a cubicle under illumination; the responses were then presented for each panelist13.

V. Result and Discussion

A. Functional Properties

Table II shows the functional properties of the sweet potato-fermented soybean composite flour. The bulk density of the flour ranges from 0.66-0.56. The bulk density decreases with increase in substitution level of soybean. The flour with 0:100% had the highest bulk density 0.66 while 30:70 had the lowest 0.56.

Water absorption capacity ranged between 24.50 and 32.50. Flour sample with SPB had the highest water absorption capacity (32.50) while 100% flour had the lowest water absorption capacity.

Dispersibility of flour samples ranged between 39.0 and 60.5. This increased with increase in substitution level of soybean. Flour sample SPR substitutions had the highest dispersibility 60.5 while 0% substitution had the lowest dispersibility 39.0.

The swelling capacity of the flour increased with increase in substitution level which ranges from 6.45 – 10.55. The flour with 30% substitution with soybean flour had the highest value of swelling capacity 10.55 and 0% substitution had the lowest value. The higher the substitution levels the higher the rate at which the flour swell.

The wettability of flour ranges from 122.5 – 244. Flour with 0% substitution had the highest wettability 244 while the 30% had the lowest wet-ability 122.5. As the substitution level increased the rate of wettability tended to decrease. Lesser time is required as the substitution level increases.

B. Proximate Analysis Result

Table III shows the proximate composition of cookies produced from blends of sweet potato flour (SPF) and soy bean flour (SBF). The proximate composition result showed that protein, fat and ash increased as the proportion of soy bean flour increased ranging from 13.8-21.7%, 5.44-6.85% and 2.2-2.67% respectively. Also, the same trend was observed for crude fibre. This indicates that supplementing sweet potato flour with soy bean flour would greatly improve the `protein quality of cookies since that was the focus of the study. This could obviously be due to the significant quantity of protein in the soy bean flour. The moisture content of the cookies (sample SPI, SPB, SPT and SPR) ranges from 2.13-3.42%. Cookies produced from 100% SPF had the highest moisture content 3.42% while cookies produced from 30% SPF had the lowest moisture content 2.13%. The moisture content decreases as the supplementation increases. The protein content ranges between 13.8-21.7%. Cookies produced from 30% soybean having the highest protein content of about 21.65% of the total nutritional composition. This result indicates that the aim of enrichment was to increase the protein content. These findings were in agreement with the work of Kolapo and Sanni [14], on processing and characteristics of soybean – fortified tapioca. This similar observation was made by Akubor [4], who showed an increase in the protein content with corresponding increase in the proportion of breadfruit flour supplementation in biscuit production from wheat- breadfruit flour blends, hence the use of mushroom to raise the protein content to more than 12% as compared with cookies made from only from wheat flour. This similar observation was made in a research study by Oluwole and Karim, [21], which showed an increase in the protein content with corresponding increase in the proportion of bambara flour supplementation in biscuit production from cassava-wheat-bambara flour blends. The ash content ranges between 2.20%-2.67% with cookies produced from 30% soybean supplementation having ash content of 2.67% while cookies produced from 100% sweet potato flour had 2.2% ash content. The ash and fat content of the sweet potato supplemented soybean flour was noted to assume the same trend as the protein content.

Carbohydrate content of the cookies ranges between 88.2% - 90.45%. Sample SPR had the lowest carbohydrate content of 88.2% while sample SPI had the lowest carbohydrate content.

Also, the same trend was observed for crude fibre. This indicates that supplementing sweet potato flour with soy bean flour would greatly improve the protein nutritional quality of cookies produced. The highest fat and ash content of 5.25% and 2.67% were recorded for the 30%. Soy bean seeds have been reported to contain appreciable amount of minerals and fat.

Energy content is a parameter used to determine the quality of food especially for formulations designed for adult with high energy requirements. Food energy is the amount of calorie available from food that is available through oxidation. Nutritionist usually talk about the number of calorie in a gram of a nutrient, but this implies that the food actually contain energy. Fats have the greatest amount of food energy 9kcal/g while proteins and most carbohydrates have about 4kcal/g. The calorie content of the cookies has been increased from 371.3 to 391.73kcal with the addition of soybean flour.

VI. Sensory Evaluation

Table III shows the sensory evaluation results. The color of cookies ranges from 1.78-2.03 with which sample had the highest SPI had the highest score 2.03 and SPR had the lowest 1.78. No significant difference was observed up to 10% blending with soybean flour in color as the substitution increases the color becomes darker. The color of the cookies changed from creamy to dark brown as substitution level increased. The dark color may be due to maillard reaction between reducing sugar and protein [9].

The crispness of the cookies decreases with increase in soybean flour ranging from 2.19 to 2.03. SPI sample had the highest crispness 2.19 while SPR sample had the lowest score for crispness. The slight decrease in crispness with increase in soybean flour substitution may due to the effect of the total fat content of soybean which is about 19.9g of 100g of soybean.

Taste is the primary factor that determines the acceptability of any product which has the highest impact as far as market success of product is concerned. The preferences for taste of the samples also showed an increase in increasing substitution of soybean. Sample SPI was the least preferred in taste among the samples.

The overall acceptability of the sample was given to the SPT sample with 20% with soybean substitution by the panelists with 2.11 rating, and SPR having the least 1.86. It was noted that the overall acceptability was determined by increase in soybean flour and was concluded that cookies with substitution up to 20% level of soybean could be baked with satisfactory performance and acceptance.

VII. Conclusion

The findings of this research revealed that the cookies produced with soybean flour substitution up to 20% was nutritionally superior to that of the whole sweet potato flour cookies. The high protein content in the sweet potato-soybean supplemented food would be of nutritional importance in most developing countries like Nigeria where many people can hardly afford high proteinous foods because of their high cost. Therefore it can be concluded that addition of soybean flour to cereal flour (sweet potato flour) enhanced the nutritional composition of the cookies.

The economic impact of utilization of flour produced from indigenous crops (sweet potato-soybean flour) will enhance gross domestic products in Nigeria and bring about reduction in foreign exchange on wheat importation. It can also be suggested in the snacking pattern of children and adults in Nigeria.

TABLE II
Functional Properties of Sweet Potato and Fermented Soybean Flour

Functional Properties	SPI	SPB	SPT	SPR
Bulk Density(G/Ml)	0.66±0.04	0.62±0.04	0.57±0.04	0.56±0.04
Water Absorption Capacity (%)	24.50±3.54	32.50±3.54	26.5±3.54	27.5±3.54
Dispersibility	39±1.41	46.5±3.54	53.0±2.83	60.5±3.54
Swelling Capacity (%)	6.45±0.35	8.15±0.03	8.75±0.06	10.55±0.04
Wettability (Secs)	244±5.65	242.5±3.54	182±2.83	122.5±3.54

TABLE III
Proximate Composition of Cookies

	Moisture (%)	Protein (%)	Ash (%)	Crude fibre (%)	Fat (%)	CHO (%)	Energy Kcal/100g
SPI	3.42±0.11	13.75±0.35	2.20±0.01	3.08±0.04	1.22±0.06	76.28±0.01	371.3±2.83
SPB	2.25±0.11	17.65±1.63	2.24±0.01	3.29±0.01	3.20±0.07	70.32±0.03	380.88±7.13
SPT	3.12±0.14	19.88±0.11	2.32±0.04	3.42±0.05	4.80±0.01	66.54±0.01	388.56±8.51
SPR	2.13±0.09	21.65±0.21	2.57±0.06	4.83±0.04	5.25±0.04	64.52±0.13	391.73±2.84

TABLE IV
Sensory Evaluation Of Cookies

	Colour	Cripsness	Taste	Overall
SPI	2.03±0.65	2.19±0.86	1.89±0.89	1.86±0.87
SPB	2.00±1.07	2.14±0.72	1.92±0.81	2.06±0.79
SPT	1.86±0.87	2.06±0.71	2.14±0.87	2.11±0.82
SPR	1.78±0.76	2.03±0.70	1.94±0.89	1.86±0.72

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