



Development, Nutrient Composition and Sensory Properties of Biscuits Produced from Composite Flour of Wheat and African Yam Bean

Atinuke Olamide Idowu^{1*}

¹Department of Transport and Tourism Studies, Food Science and Hospitality Section Redeemer's University (RUN), Km 46/48 Lagos/Ibadan Expressway, Mowe, Ogun State, Nigeria.

Author's contribution

This whole work was carried out by the author AOI.

Original Research Article

Received 27th September 2013
Accepted 2nd November 2013
Published 11th March 2014

ABSTRACT

The aim of the study was to improve the protein content of biscuit; a low protein but widely consumed snack by school-aged children. The study was carried out at the Department of Crop Utilization; International Institute of Tropical Agriculture (IITA), Ibadan between March, 2012 and December, 2012. Composite flour was produced from African yam bean (a nutrient-dense but underutilized legume) flour (AYBF) and wheat flour (WF). The composite flour was prepared at various ratios WF/AYBF 100:0, 80:20, 70:30 and 60:40 and used to produce biscuits. These biscuits samples were analysed and the 100/0 WF: AYBF biscuit served as control. Proximate analysis, crispness (breaking force) and sensory evaluation of the biscuit samples were determined using standard methods. Proximate analysis showed significant increase ($P=0.05$) in protein (9.61-14.71%), ash (1.37-2.42%) and sugar (14.11-21.29%) and significant decrease in starch (76.66-51.15%) and fat (12.53-8.13%) contents with increase in AYBF in the biscuits. There was no significant difference in the moisture contents of the test samples. Crispness of the biscuit increased with increase in percentage of AYBF in the flour blend. The breaking force values reduced from 8.5kg (for 100/0 WF: AYBF biscuits) to 3.0kg (60/40 WF: AYBF biscuits). Lower breaking force was found to correspond with higher crispness. Sensory evaluation results showed that all biscuit samples had high rating for

*Corresponding author: E-mail: gb.tinu04@yahoo.com;

all evaluated attributes. The closeness of values obtained for all biscuit samples to the control sample indicate a high level of acceptance of the AYBF-WF biscuits. Hence, suggesting a way of obtaining biscuits with higher protein content.

Keywords: Biscuit; African yam bean; wheat flour; protein content.

1. INTRODUCTION

Snacks are generally consumed by all and sundry especially among school-aged children in Nigeria. According to Tettweiler [1], a snack is a small meal in the broadest sense “and snacking is the consumption of easy- to- handle (convenience) food products in either solid or liquid form, with little or no preparation. It is eaten in little amounts usually between main meals or instead of a meal. A snack food however is commonly used as convenience food. The need for convenience food is borne out of the need to spend less valuable time and energy in the kitchen preparing meals [2]. High consumption of snacks by growing children necessitates the need to make it of high nutritional quality that could be useful in nutritional programmes to combat malnutrition and nutritional deficiencies. In Nigeria, snack categories range from the traditional snacks produced from indigenous cereals and legumes such as maize and groundnut (*kulikuli, donkwa, guguru, Aadun, kokoro and so on*) to other snacks (biscuits, cookies) produced from wheat, rye, barley and other cereals of foreign origin [3]. Upgrading nutritional quality of these snacks involves utilization of inexpensive protein sources. Legume flours have been recommended as cheap and good sources of protein for upgrading nutritional quality of wheat and other cereal flour in biscuits and other food preparations [4]. Although their level of use in baked goods is limited by their characteristic beany flavor and reduced gluten content, they could still be utilized for biscuits and other snack foods where weaker flours are desirable and the beany flavor can also be minimized. The use of high level of sugar in formulations for legume-based biscuits have been reported to offset the undesirable beany flavor [5]. The use of high level of sugar in low wheat gluten biscuit recipe has also been reported to improve biscuit strength since sugar, apart from its sweetness value introduces structural firmness by setting hard in the biscuit matrix from a molten stage [6].

African yam beans (AYB) (*Sphenostylis stenocarpa*) is one of the less utilized legumes that are gradually going into extinction [7]; it is nutrient-dense but classified as neglected underutilized species (NUS) legume [8]. Its utilization varies from cooked beans to fermented sauce [9]. It is grown throughout tropical Africa, most commonly in Central and Western Africa, especially in Eastern Nigeria, where it is grown for its seeds. It is also reported to be cultivated in Ivory Coast, Ghana, Gabon, Congo, Ethiopia and parts of East Africa [10]. It grows well in acid and highly leached sandy soils of the humid lowland tropics where other major food legumes do not flourish. It suffers less of pest damage than the other legumes both in cultivation and storage and it has the potential to meet year-round protein requirement if grown on a large scale [11]. AYB has attracted research interest because of its nutrient content. Amino acid analyses indicate that the lysine and methionine levels in the protein are equal to or better than, those of soybeans while most of the other essential amino acids corresponds to WHO/FAO recommendation [12]. A protein content ranging between 20.2 and 21.2% has been reported for African yam bean by Eneche [13]. Its protein concentrate has been reported to be used in fortification of starchy foods like maize, cassava and *akamu* flours [14]. Despite the availability and the nutritional contents of this crop, it is still underutilized and rarely consumed in urban areas. This has been attributed to its elaborate preparation method due to its characteristic “hard-to-cook” phenomenon.

Biscuit is a convectional snack produced from wheat flour with other ingredients; sugar, margarine, salt, baking powder. Just like any other cereal-based foods, it is high in carbohydrate, but low in protein, therefore, improving protein content of such highly consumed snack among school-aged children can not be over-emphasized. Wheat flour like other cereals is limiting in lysine and tryptophan and rich in sulphur containing amino acids while the reverse is the case for African yam bean [15]. The protein of wheat flour and African yam bean thus complement each other's limiting amino acids. Therefore, incorporation of African yam bean flour into wheat-based biscuits makes it useful protein and energy sources with better nutritive value. Biscuits have been classified by Okaka and Isieh [16] into four different categories according to their sugar levels. Soft-dough biscuits containing 25% sugar (digestive) and 32% sugar (short cake) or flow-type biscuits containing 59 percent sugar (schellford) and 79 percent sugar (gingernuts). Formulations for legume-based biscuits with high sugar levels have been reported to limit beaniness. Therefore, 59 percent sugar biscuit type was produced in this study with the aim of attaining negligible beany flavor in the biscuits since higher level of sugar has been reported to offset beany flavor [5].

The objective of this study was to develop biscuits produced from wheat and African yam bean flours, evaluate its nutrient composition and acceptability. Thus, creating a novel use for AYB and improving nutritional quality of biscuits.

2. MATERIALS AND METHODS

Wheat flour was purchased from a retail market, Bodija, Ibadan in Oyo State, Nigeria. While African yam bean seeds were sourced from a local market, Umuahia in Abia state, Nigeria and classified at the IITA Genetic Resource Centre as accession, Tss 30. The African yam bean seeds were sorted, washed, dehulled manually after soaking in water (1:5w/v) for about 4h at 29±2°C. The dehulled seeds were dried at 60±2°C, milled using a laboratory hammer mill (model ED-5, Thomas Wiley, England) and sieved into fine flour with 1mm mesh sieve. The purchased wheat flour was sieved using the same mesh screen to obtain the same particle size with African yam bean flour. Parts of Wheat flour were substituted with 20, 30 and 40% African yam bean flour by weights. Each flour sample was separately mixed using a Kenwood mixer (OWHM 220001) of England for three minutes at high speed. The various flour samples were packed separately in airtight plastic containers till needed.

2.1 Preparation of Biscuits

Table 1 showed the recipe used for making the wheat-African yam bean biscuits samples. Biscuits were prepared by modifying the method of Okaka and Isieh [16]. The composite flour and other dry ingredients were mixed thoroughly by hand followed by rubbing-in the margarine. Liquid whole egg and water were added gradually to make stiff dough, which was rolled out on a floured board and cut into uniform sizes using biscuit cutter. The surface was pricked with a fork to prevent the dough from rising. The cut-out biscuit dough were baked on lightly oiled trays in a hot oven at 175°C for 15min, cooled, packed in zip-lock bags and stored at ambient temperature (25-27°C).

Table 1. Recipe for preparation of composite biscuit samples from wheat and African yam bean flour

Ingredients	Quantity
wheat-AYB flour (g)	200
Margarine (g)	100
Sugar (g)	118
Whole eggs (ml)	50
Water (ml)	30
Salt (g)	3
Baking powder (g)	3

2.2 Proximate Analysis

Proximate analysis of the Wheat-AYB biscuit samples were carried out in triplicates. Moisture, protein, ash and fat contents of the samples were determined using AOAC method [17]. The starch and total sugars contents were determined using a colorimetric method [17].

2.2.1 Crude fat content

Crude fat content of the sample was determined using the method of AOAC [17]. Crude fat was extracted from 3g of the sample with hexane using a fat extractor (Soxtec System HT2 fat extractor), and the solvent evaporated off to get the fat. The difference between the initial and final weight of the extraction cup was recorded as the crude fat content.

2.2.2 Crude protein content

Crude Protein content was determined by Kjeldahl method [18]. Exactly 0.2 g of sample was weighed into digestion tube and one tablet of Kjeldahl catalyst (copper) and 4mL of conc. H_2SO_4 were added. This was transferred into a fume cupboard and 4mL of H_2O_2 was added, fuming was allowed to stop. The mixture was placed on Tecator digestion block pre-set at 420°C and digested for 1h; at the end of which all organically-bound nitrogen was converted to ammonium hydrogen sulphate. With the addition of a strong alkali (NaOH, 40%) and the application of heat, ammonia NH_3 was distilled out, and collected in 1% boric acid receiver solution containing bromocresol green/methyl red indicator. Blanks were prepared and treated similarly. Rack of digestion tubes was removed from the block and allowed to cool to room temperature. The tube containing the blank sample was placed in the distillation unit of the system, and the weight of the sample to be analyzed was entered using the key board on the system and the system was allowed to automatically perform the distillation and titration of the sample. Likewise, in turns, the tubes containing the samples' digest were placed in the distilling unit of the system. The system was programmed to automatically perform the distillation and titration. Results of crude protein content of each sample were displayed on the screen of the protein analyzer at the end of each analysis.

2.2.3 Starch and sugar content

The method of [17] was used. Finely ground samples (0.02 g) were weighed into centrifuge tubes and 1 mL of ethanol was added followed by 2 mL of distilled water and 10 mL hot ethanol. The mixture was vortexed and centrifuged using Sorvall centrifuge (Newtown, Connecticut, USA, model GLC-1) at 2000 rpm for ten minutes. The supernatant was collected and used for free sugar analysis, while the residue was used for starch analysis. To the

residue, 7.5 mL perchloric acid was added and allowed to hydrolyze for 1 hour. It was diluted to 25 mL with distilled water and filtered through Whatman no 2 filter papers. From the filtrate, 0.05 mL was taken, made up to 1 mL with distilled water, vortexed and developed for color and the absorbance was read on a spectrophotometer (Milton Roy Company, USA, model Spectronic 601) at 490 nm wavelength.

On the other hand, the supernatant for sugar analysis was made up to 20 mL with distilled water; an aliquot of 0.2 mL was taken and 0.5 mL (5% phenol), followed by 2.5 mL concentrated sulphuric acid were added. The sample was allowed to cool and the absorbance read on a spectrophotometer.

$$\%Sugar = Abs - Intercept \times \frac{Dilution\ factor \times volume}{weight\ of\ sample \times slope \times 10,000} \dots\dots\dots 1.0$$

Where: Abs. = Absorbance; Dilution factor = 5; Volume = 20ml

$$\%Starch = Abs - intercept \times \frac{Dilution\ factor \times Volume \times 0.9}{weight\ of\ sample \times slope \times 10,000} \dots\dots\dots 2.0$$

Where: Abs. = Absorbance; Dilution factor = 20; Volume = 25ml.

Note: The slope and intercept used for the calculations was from standard glucose curve.

2.3 Breaking Force Determination

A texture analyzer (Model –no 174886, Kiya Seisakusho Ltd. Tokyo Japan.) was used for breaking force determination [19]. Each biscuit stick was placed over the surface of a stainless plate and pressed with a stainless steel ball flat-end plunger (20mm diameter) at a speed of 2.5mm/min. This was repeated four times to determine the breaking force value as the average of the four determinations and numerical results were expressed in kilograms (kg).

2.4 Sensory Evaluation

Ten semi-trained panelists were selected from staff and graduates of International Institute of Tropical Agriculture (IITA), Ibadan, Oyo state, Nigeria. The panelists were screened with respect to their interest and ability to differentiate food sensory properties as described by Iwe [20]. The study was carried out in a well illuminated sensory evaluation room of IITA in the mid morning hours (10.00am). Each panelist was provided with a glass of clean water to rinse their mouths between the four evaluation sessions of 3min interval. The 100% wheat flour samples served as control. The four samples were presented in two digit coded plates and were evaluated for appearance, taste, crispness, colour, aroma and overall acceptability using a nine point hedonic scale in which 1 represents the least score (dislike extremely) and 9 the most desirable score (like extremely) for all attributes [20].

2.5 Statistical Analysis

Data generated from the study was subjected to Analysis of Variance (ANOVA) using SPSS (version 17). Means were separated using LSD and showed significantly different at 95% confidence level ($P=0.05$).

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Biscuits Produced from Composite Flour of Wheat and African Yam Bean

The proximate compositions of the composite biscuits were determined and the results were presented in Table 2. From the table, considerable increase was observed in the proximate compositions of the biscuit samples. Protein, ash and sugar contents increased significantly ($P=0.05$) from the control sample A (100%WF0%AYBF) to sample D (60%WF40%AYBF). The observed increase in these parameters increased with increasing level of supplementation of the wheat flour with African yam bean flour. The protein content of the biscuit samples increased (9.61-14.71%) as the level of AYBF substitution increased. This obviously could be attributed to the crude protein of the AYBF. A similar trend was observed by Alozie, Udofia [21] for production of cakes from wheat and African yam bean flour blends. And also Akaerue and Onwuka [22] for composite biscuits from Mung bean and wheat flour. The ash content increased (1.37-2.42%) with increase in AYBF content in the biscuits. This could be because AYB comparably contains higher ash than wheat. It then follows that incorporation of AYBF in biscuit making could enhance the mineral intake of many people, as ash is indicative of the amount of minerals contained in any food sample. The increase in sugar content (14.11-21.29%) may improve the energy values of the biscuits in addition to higher levels of protein. As the level of AYBF increased, the fat (12.53-8.13) and starch contents (76.66-51.13%) reduced significantly ($P=0.05$). The decrease obtained in the fat contents of the biscuit samples may be attributed to the fact that AYBF has been observed to contain low values of crude fat [13]. This also makes composite biscuit from AYBF desirable because of the low fat and the fact that low fat food products are less susceptible to rancidity and hence, more shelf stable. The starch contents of the biscuits were decreased, with 100% WF having the highest value. This could also be because wheat flour has higher starch content than AYBF. Moisture content showed no significant difference with increase in AYBF. The moisture contents were minimal and may not have adverse effect on the quality attributes of the products.

3.2 Breaking Force of Biscuits Produced from Composite Flour of Wheat and African Yam Bean

The breaking force of the biscuit samples was determined and presented in Table 3. The breaking force was found to be an indicator of the crispness of the biscuit samples, with lower breaking force corresponding to higher crispness. This is similar to the report of [23]. Table 3 showed that the values obtained for the breaking force ranged between 3.00-8.50kg. The 100% wheat flour biscuit exhibited the highest breaking force (8.50kg) which implies that the sample is the least in terms of crispness. A similar value was obtained by Okaka and Isieh [16] for cowpea-wheat biscuits. The breaking force of the biscuit samples was observed to reduce with increase in quantity (%) of AYBF. This implies that higher crispness was obtained for the biscuit samples with increasing AYBF. Crispy biscuit samples are expected to exhibit lower breaking force due to its crispy/crunchy texture which allows it to attain the break point quicker.

3.3 Sensory Evaluation of the Biscuit Samples

Results from sensory evaluation (Table 4) showed that all snack samples were generally accepted for all attributes evaluated as none scored below the minimum acceptable rating of

5 on the 9 point hedonic scale. The sample from 20% AYBF showed no significant difference with the control sample for the overall acceptability. The values obtained for taste of all the tested samples showed no significant difference which shows a high level of acceptance of the AYBF-WF biscuits by the panelists. Increase in values obtained for crispness with increase in AYBF of biscuit samples is an agreement with values obtained for breaking force of the biscuit samples. Values obtained for the aroma showed that the beany flavor was negligible in the biscuit samples. This is attributed to the use of high level of sugar which has been reported to off-set the undesirable flavor of legume-based composite biscuits [5].

Generally, closeness of values obtained for all AYBF-WF biscuit samples to the control sample indicate a high level of acceptance of the AYBF-WF biscuits, thereby improving the nutritional contents of biscuits as well as increasing the utilization of African yam bean.

Table 2. Proximate composition of biscuits made from blends of wheat and African yam beans flour

	Samples			
	A(WF:AYBF100:0)	B(WF:AYBF80:20)	C(WF:AYBF70:30)	D(WF:AYBF60:40)
Ash	1.37d	2.09c	2.21b	2.42a
Moisture	11.11a	11.04a	11.24a	11.17a
Protein	9.61d	12.16c	13.72b	14.71a
Fat	12.53a	10.70b	9.57c	8.13d
Starch	76.66a	68.71b	54.71c	51.13d
Sugar	14.11c	15.14c	18.32b	21.29a

Values with different letters along the row are significantly different at P=.05

Table 3. Breaking force of biscuits made from blends of wheat and African yam beans flour

Samples	Breaking force (Kg)
A (WF:AYBF 100:0)	8.50a
B (WF:AYBF 80:20)	6.00b
C (WF:AYBF 70:30)	4.50c
D (WF:AYBF 60:40)	3.00d

Values with the different letters along the column are significantly different at P=.05

Table 4. Sensory Evaluation scores of biscuits samples produced from blends of wheat and African yam beans flour

Parameter	Samples			
	A(WF:AYBF100:0)	B(WF:AYBF80:20)	C(WF:AYBF70:30)	D(WF:AYBF60:40)
Appearance	6.7c	7.4b	7.5b	7.8a
Taste	6.7a	6.6a	6.6a	6.5a
Crispness	5.8c	6.3b	7.2a	7.5a
Colour	8.0a	7.2b	7.0b	5.9c
Aroma	7.2a	7.0b	7.0b	7.2b
Overall acceptability	7.3a	7.2a	6.9b	6.8b

Values with the different letters along the row are significantly different at P=.05

4. CONCLUSION

Biscuits of acceptable sensory and chemical quality have been produced from AYB-wheat composite flour thereby suggesting an improvement for the nutritional content of biscuit, a widely consumed snack in Nigeria especially among school-aged children and also creating a novel use for AYB.

ACKNOWLEDGEMENTS

The author wishes to thank the staff and management of International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria for the use of their equipment and the management of Redeemer's University (RUN), Mowe, Ogun State for approval of research leave to carry out this study.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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