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Quality Evaluation of Biscuits Produced From Wheat, Sorghum and African Yam Bean Composite Flours

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Abstract

This study was carried out to determine the suitability of wheat, sorghum and African yam bean composite flour in the development of biscuits. Sorghum and African yam bean were processed into fine flours. Five blends of composite flours were prepared by mixing wheat, sorghum and African yam bean flours in the following proportions: 90:5:5 (AA1), 80:10:10 (BB2), 70:15:15 (CC3), 60:20:20 (DD4), 50:25:25 (EE5) and 100% whole wheat flour was used as the control (FF6). The composite flours were used to produce biscuits which were evaluated for their proximate composition and sensory acceptability. The proximate composition of the biscuit samples varied significantly ($p<0.05$) from 10.00 - 24.00%, 2.00 - 10.09%, 9.81 - 11.92%, 4.18 - 7.50%, 5.15 - 7.70% and 45.96 - 65.54% for moisture, ash, protein, fat, crude fiber and carbohydrate content of the biscuits, respectively. It was observed that incorporation of both sorghum and African yam bean flours in the biscuits significantly increased the moisture, ash, protein and crude fibre contents while the fat and carbohydrate content of the composite samples were reduced. The mean scores for the sensory evaluation of the biscuits showed that the colour, taste, aroma, texture and overall acceptability of the whole sample were all liked by the panelists as they rated all the quality attributes above average. This shows the possibility of producing nutritious cookies with desirable organoleptic qualities from wheat, sorghum and African yam bean flour. The findings of this study when implemented will help to reduce over dependency in imported wheat flour, thereby reducing huge amount of money spent in foreign exchange.

Keywords: Biscuit, wheat, sorghum, African yam bean, proximate composition.

Introduction: Biscuits may be regarded as a form of confectionery dried to a very low moisture content which is made from unleavened dough (Obi and Nwakalor, 2015). They are ready-to-eat, convenient and inexpensive food products, containing digestive and dietary principles of vital importance. The major ingredients for production of biscuits are flour, fat, sugar, salt and water, which are mixed together with other minor ingredients, such as baking powder, skimmed milk, emulsifier and sodium meta-bisulphite to form dough containing a gluten network (Oyedele, Oluwafemi, Adepeju, Otutu and Oluwasola, 2017). According to Nwakalor (2014), the dough is rested for a period and passed between rollers to make a sheet. These sheets are however, transformed into appetizing product through the application of heat in the oven. Alebiosu, Akinbode, Oni and Oladele (2020) noted that biscuits constitute valuable amount of iron, calcium, protein, calorie, fibre and some of the B-vitamins and they are classified based on the ingredient composition and processing techniques.

The basic ingredient for production of biscuit is wheat flour (Obi and Nwakalor, 2015). Wheat (*Triticum aestivum*) is one of the most useful and valuable crops grown around the world and it is considered as almost first among cereal largely due to the fact that its grain contains protein with unique chemical and physical properties, and other vital nutrients (Adeyanju,Babarinde, Olanipekun, Bolarinwa and Oladokun, 2021). However, Nigeria has unfavorable climatic condition for wheat cultivation but suitable for tropical crops such as roots, tubers, legumes and other cereals. Therefore, consumption of cereal based foods like biscuits require development of an adequate substitute for wheat. This has led to the use of composite flour in bakery products because of the economic and nutritional advantages attached to it (Bolarinwa,Abioye, Adeyanju and Kareen, 2016).

Composite flour according to Peter-Ikechukwu, Ogazi, Uzoukwu, Kabuo and Chukwu (2020) can be defined as a mixture of different ratios of non-wheat flours obtained from roots and tubers, cereals, legumes, etc., with or without the addition of wheat flour. Composite flour has often been used with the intent of reducing importation of wheat and improving its nutritional value, most especially in countries where, wheat crop is not grown. The use of composite flour also promotes the use of some locally cultivated crops as flour and increases the nutritional content of food products. Wheat flour is lacking in some limiting amino acids, such as lysine and threonine, even though it is considered as good source of calories and other nutrients. Thus compositing wheat flour with locally available flours from other cereals and legumes such as sorghum and African yam bean is expected to increase its nutritional quality.

Sorghum (*Sorghum bicolor*) is an important food crop grown on a subsistence level by farmers in the semi-arid tropics of Africa and Asia. It is one of the principal crops grown in northern Nigeria (Alebiosu *et al.*, 2020). It is typically an annual crop but some cultivars are perennial, commonly called guinea corn

in West Africa. Sorghum contains between 11.30-13.00% proteins, 1-3.30% fat, 3-6.00% dietary fibre, and 70-74.63% carbohydrate. Sorghum is high in antioxidants which acts as a neutraceutical and helps to lower the risk of cancer, diabetes, heart diseases, among others (Arukwe,Ezeocha and Ubbor, 2021). It is the principal source of energy, protein, vitamins, and minerals for millions of the poorest in these regions. Its products are deficient in essential amino acids such as lysine, threonine, tryptophan and the presence of anti-nutritional factors such as tannins and phytates limit their nutritional value (Folake, Abiodun and Oluwatomiwo, 2018). Therefore, attempts have been made to fortify these cereals with legumes or other cereals to make it nutritionally superior and acceptable products (Adegbola, Awagu, Kamaldeen and Kasheta, 2013).

The African Yam Bean (*Sphenostylis stenocarpa Hochst ex. A. Rich.*) is one of the under-utilized tropical African tuberous legumes found in Nigeria, Central African Republic, Gabon, Zaire and Ethiopia. It is of special value considering that it has duo food products (grain and tuber). The high protein composition of African yam bean makes it an important source of protein in the diet of many tropical countries (Ukpong *et al.*, 2021). In Nigeria it is commonly called *okpo dudu* or *odudu* or *azam* (Igbo), *girigiri* (Hausa), *sese* (Yoruba) and *nsama* (Ibibio). The nutritional content show that African yam bean is rich in protein, carbohydrate, vitamins and minerals and its protein contains equal or better levels of lysine and methionine than those of soybeans (Arukwe *et al*.,__2021). Therefore, substituting it with cereal flours in the production of biscuits would supply the lysine absent in them. This legume has also been reported to be of importance in the management of chronic diseases like hypertension, diabetes, and cardiovascular diseases because of its high dietary fibre content (Adeyanju *et al.*, 2021). It is eaten roasted, as groundnut or boiled and blended with ingredients like oil, pepper and salt. It is consumed in different form such as snacks, delicacy, main meal etc. It can be used for the fortification of other foods (Obi and Nwakalor, 2015). In spite of all this, African yam bean is underutilized and hardly consumed in urban areas which are attributed to its complex preparation method. The use of African yam bean in composite flour for cookies production will make it readily available for consumption by all persons.

Nowadays, extensive studies on the preparation of biscuits by fortification with some natively available and better nutritional value flours have been conducted (Obi and Nwakalor, 2015; Folake *et al.*, 2018; Arukwe *et al.*, 2021). Producing less gluten biscuits from wheat-sorghum-African yam bean flour blend may enhance the nutritional and health status of consumers. The utilization of wheat, sorghum and African yam bean in the production of baked goods are not well known in Nigeria and there is scanty information on the utilization of sorghum and African yam bean in Nigerian foods since they are both underutilized cereals and legumes respectively. Hence, this study seeks to evaluate the quality attributes of biscuits produced from composite flour from wheat, sorghum and African yam bean flour. The aim of this study is to evaluate the quality attributes of cookies produced from blends wheat, sorghum and African yam bean flour. The specific objectives of the study include:; To produce sorghum and African yam bean flours.; To formulate composite flours by blending wheat, sorghum and African Yam bean.; To produce biscuits from the composite flours.; To determine the proximate composition of the biscuit produced.; To evaluate the sensory qualities of the biscuits.

Materials and Methods: Source of Materials: Sorghum grains, commercial wheat flour and baking ingredients (egg, milk, baking powder, sugar, margarine and vanilla flavor) will be obtained from Eke Oko Market in Anambra State while African yam bean seeds will be purchased from Ogboete Main Market in Enugu State. All the materials will be packaged in a clean bag and taken to the Food Processing Laboratory of Department of Food Technology, Federal Polytechnic Oko, Anambra State; for further processing and analysis.

Sample Preparation: Preparation Sorghum Flour: Sorghum flour will be prepared by adopting the method described in the study of Alebiosu *et al.* (2020) with slight modification. Sorghum grains will be cleaned and sorted to remove stones and other extraneous materials. The grains will be washed with potable water and dried in cabinet dryer at 70ºC for 8hrs. The dried grains will be milled and sieved to obtain fine flour. The flour produced will be packaged in an airtight container prior to further use.

Preparation of African Yam Bean Flour The method described in the study of Adeyanju *et al.* (2021) will be adopted in the production of African yam bean flour with slight modification. Three kilograms (3kg) of white African yam beans will be sorted and washed thoroughly with clean tap water to remove unwholesome seeds, stones and adhering dusts. Thereafter, it will be soaked for 12 hours, boiled for 30 minutes and dehulled. The beans were dried in a cabinet dryer (60ºC for 24hrs), and milled using an attrition mill. The flour obtained will be sieved, packaged in high density polyethylene bags and stored until needed for usage.

Formulation of Composite Flour: Sorghum flour, commercial wheat flour and African yam bean flour will be blended in the proportions shown in Table 1 to obtain the composite flours that will be used to produce biscuits.100% wheat flour will serve as the control.

Production of Biscuits: Biscuits will be prepared using the method described by Adeyanju *et al.* (2021). Fat and sugar will be creamed together until fluffy. The flours, baking powder, whole egg and salt will be added and manually mixed in a bowl to form a dough. The dough will be rolled to a uniform thickness, cut and baked in an oven at 170°C for 20 min. The biscuits will be removed from the oven and allowed to cool on a rack, after which they will be packaged in low-density polyethylene bags and kept in a plastic container before

Proximate Analysis: The proximate analysis of the biscuit samples was carried out using the analytical methods of AOAC (2012).

Sensory Evaluation: A semi-trained panel of 20 judges made up of male and female staff and students of the Department of Food Technology, Federal Polytechnic, Oko will be used. The panelists will be educated on the respective descriptive terms of the sensory scales and requested to evaluate the various biscuit samples for taste, colour, texture, aroma and overall acceptability using a 9-point Hedonic scale, where 9 will be equivalent to like extremely and 1 meant dislike extremely. Presentation of coded samples will be done randomly and portable water will be provided for rinsing of mouth in between the respective evaluations (Iwe *et al.*, 2014).

Statistical Analysis: All measurements will be carried out in triplicate. The data generated will be analyzed using statistical program SPSS (version 25.0) and significant difference will be compared by Analysis of Variance test (ANOVA) following Duncan's multiple range tests at the significance level of 5%.

Results and Discussion: Proximate composition (%) of biscuits produced from blends of wheat, sorghum and African yam bean flours. The results of the proximate composition of biscuits produced from blends of wheat, sorghum and African yam bean flours are presented in Table 2. The moisture content of the samples ranged from 10.00% to 24.00% with sample FF6 (100:0:0 wheat-sorghum-African yam bean flour) having the least value while sample EE5 (50:25:25 wheat-sorghum-African yam bean flour) had the highest value. There was significant difference ($p<0.05$) in the moisture content of the samples. It was observed that incorporation of sorghum and African yam bean flour significantly increased the moisture content of the biscuits. This observation is at par with the findings of Oyedele *et al.* (2017) who noted that incorporation of other flours in wheat flour increased the moisture content of the formulated product although their values (8.80 – 9.20%) were much lower than the one obtained in this study.

There was drastic increase in the ash content of the formulated biscuits. The percentage ash content of the samples ranged from 2.00% in the control sample (FF6) to 10.00% in the sample produced from 70:15:15 wheat-sorghum-African yam bean flour (CC3). Some significant differences ($p<0.05$) existed in their values, however, no significant difference ($p>0.05$) was observed in the ash content of samples AA1 (90:5:5 wheat-sorghum-African yam bean flour), BB2 (80:10:10 wheat-sorghum-African yam bean flour) and EE5 (50:25:25 wheat-sorghum-African yam bean flour). The increase in the ash content of the biscuits is obviously due to addition of both sorghum and African yam bean flours in the formulation. Similar increase in ash content (from 0.48% to 4.21%) was observed by Obasi *et al.* (2012) as the level of substitution of wheat flour with African yam bean flour increased although their values are lower when compared with the one in the present study. In a similar study reported by Arukwe *et al.* (2021), the ash content of biscuits produced from sprouted wheat, sorghum and African yam bean flours were very low (1.83 – 3.95%) compared to the one in the present study. This could be attributed to difference in the processing methods used as well as varietal differences in the cereal and legume grains used. As expected, the protein content of the formulated biscuits also increased significantly from 9.81% to 11.92% with the control sample (FF6) having the least value while the sample produced from 50:25:25 wheat-sorghum-African yam bean composite flour (EE5) had the highest values. The results revealed a significant difference ($p<0.05$) in the protein content of the samples. These values tallied with the findings of Alebiosu *et al.* (2020) who reported values ranging from 9.18% to 11.78% for biscuits produced from composite flours of wheat, sorghum and defatted coconut kernel but lower than 12.62% to 19.52% reported by Ukpong *et al.* (2021) for biscuits produced from wheat and African yam bean tempeh. Also, Obasi *et al.* (2012) and Durojaiye *et al.* (2018) reported higher protein contents ranging from 12.57 – 22.00% and 13.11 – 18.61% respectively; for biscuits produced from different composite flours. The varied results could be due to differences in the raw materials and blending ratio used. The fat content of the samples ranged from 4.18 – 7.50% with sample EE5 (50:25:25 wheat-sorghum-African yam bean flour) having the least value while the control sample (FF6) had the highest value. There was significant difference ($p<0.05$) in the fat content of the products. The results revealed that incorporation of both sorghum and African yam bean flour in the product reduced the fat content significantly. This is not in line with the observation of Arukwe *et al.* (2021) who noted that inclusion of sprouted sorghum and African yam bean flour in biscuit formulation significantly increased the fat content. The varied results may be due to the differences in the processing methods used.

crude fibre content of the biscuit samples ranged from 5.15% to 7.70% with the control sample (FF6) having the least score while the sample CC3 had the highest values. The result showed that inclusion of both sorghum and African yam bean flour increased the fibre content of the biscuits although no definite trend was observed. These results are higher than 2.00 - 4.90% and 2.77 – 3.74% reported by Arukwe *et al.* (2021) and Alebiosu *et al.* (2020) respectively for biscuits produced from different composite flours. This could be due to the differences in the raw materials used as well as the varied processing methods employed. The carbohydrate content of the flour ranged from 45.96% to 65.54% with sample FF6 (control) having the highest and 50:25:25 wheat, sorghum and African yam bean (EE5) having the lowest value. It was observed that addition of both sorghum and African yam bean flour drastically reduced the carbohydrate content of the biscuits. Other studies have also reported decrease in carbohydrate content of baked goods when cereals were blended with legumes (Obasi *et al.* 2012; Bolarinwa *et al.*, 2016; Alebiosu *et al.*, 2020; Ukpong *et al.*, 2021; Arukwe *et al.*, 2021). The carbohydrate content obtained in this study was however; lower

than the carbohydrate content (57.97 - 73.89%) of sprouted wheat-sorghum composite biscuits enriched with African yam bean flour (Arukwe *et al.*, 2021).

Mean scores for sensory evaluation of biscuits produced from blends of wheat, sorghum and African yam bean flours.: The results of the sensory evaluation of biscuit samples are as presented in Table 3. There was some significant ($p<0.05$) difference in the taste the samples. Means scores of taste of the biscuit samples ranged from 7.50 to 8.55. Sample DD4 (60:20:20 wheat-sorghum-African yam bean flour) had the least score for taste while sample FF6 (100:0:0 wheat-sorghum-African yam bean flour) had the highest score. The results showed that incorporation of sorghum and African yam bean According to Oyedele *et al.* (2017), texture is another important criterion perceived when snack is chewed between the molars and is usually expressed in terms of hardness and factorability. Texture mean scores ranged between 7.40 and 8.55. The scores for Sample EE5 and FF6 were significantly ($p<0.05$) higher when compared to the rest of the composite biscuits. With reference to the 9-point hedonic scale used for the sensory analysis, the textures of the formulated biscuits were 'liked' by the panelists although their degree of likeness varied slightly with the varying level of the composite flours in the biscuit samples. The mean scores for the aroma of the biscuit samples ranged from 7.55 in samples CC3 and to 8.65 in the control sample (FF6). Some significant difference ($p<0.05$) existed in the aroma of the composite samples although they compared well with the control sample. The panelists noted that the samples containing higher percentage of African yam bean flour had beany flavor. This was expected because of the presence of the legume in the product. The mean scores for the overall acceptability of the biscuits ranged from 7.60 – 8.63. The control sample was the most accepted sample with a score of 8.63 closely followed by sample EE5 (8.45) while DD4 had the least score (7.60). The results showed that flour in the biscuits did not adversely affect their taste as their scores were above average. Alebiosu *et al.* (2020) reported similar results (6.90-8.15) for the taste of biscuits produced from wheat-sorghum-defatted coconut composite flours. With respect to colour, the biscuit samples had mean scores ranging from 7.70 – 8.75 with sample DD4 having the least scores while the control sample (FF6) had the highest scores. All the samples scored above average in terms of colour indicating that incorporation of sorghum and African yam bean flour did not adversely affect this quality attributes. Olanipekun *et al.* (2018) recorded similar scores for biscuits produced from wheat-sorghum composite flours.

substitution of wheat flour with up to 25% sorghum and African yam bean flour did not adversely affect the overall acceptability of the formulated biscuits as the panelists rated the whole samples above average.

Conclusion: The findings of the study showed that the biscuits produced have increased nutrient contents which are all desirable for good health and wellbeing. Therefore, the use of sorghum and African yam beans in biscuits formulation will go a long way in enhancing nutrition, health and wellbeing of the consumers and reduce the dependence on wheat flour, thereby saving the huge foreign exchange used in importing wheat, for other projects. It will also reduce food insecurity and diversify the use of sorghum and African yam bean.

Recommendation: This study recommends the use of both sorghum flour and African yam bean flour at up to 25% level of substitution to wheat flour in biscuit formulation since it yielded acceptable products with improved nutrients. Further study is recommended on the formulated biscuits in order to ascertain the effect of addition of these flours on the minerals, anti-nutrients and vitamin compositions as well as the shelf life of the biscuits.

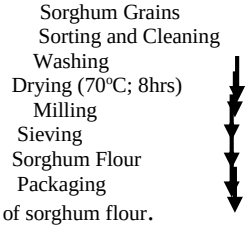

Fig. 1: Flow chart for the processing of sorghum flour.

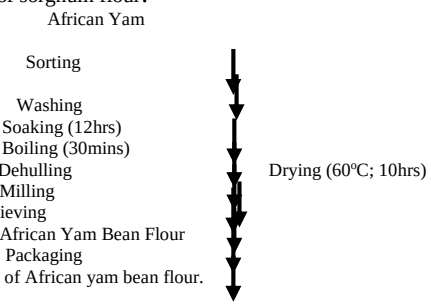

Fig. 2: Flow chart for the processing of African yam bean flour.

Table 1: Formulation of Composite Flours.

S/N	Wheat Flour	Sorghum Flour	African Yam Bean Flour
1.	100	0	0
2.	90	5	5
3.	80	10	10
4.	70	15	15
5.	60	20	20
6.	50	25	25

Creaming of Fat and Sugar
Addition of other ingredients
Mixing
Rolling and cutting
Baking (170°C; 20min)
Cooling
Packaging

Fig. 3: Flow chart for the production of biscuits

WASHING OF SORGHUM

DRYING OF SORGHUM

MILLING OF SORGHUM

AFRICAN YAM BEANS

SCALING OF THE FLOURS

MIXING OF THE FLOURS

MIXING OF THE WET INGREDIENTS

FORMING OF THE BISCUIT DOUGH

SAMPLE AA1

SAMPLE BB2

SAMPLE CC3

SAMPLE DD4

SAMPLE EE5

SAMPLE FF6

Table 2: Proximate composition (%) of biscuits produced from blends of wheat, sorghum and African yam bean flours.

Sample	Moisture	Ash	Protein	Fat	Fibre	Carbohydrate
AA1	12.00^{e}±0.4	8.12^{b}±0.01	10.94^{d}±0.0	5.80^{b}±0.1	7.51^{b}±0.0	55.63^{b}±0.03
BB2	20.00^{b}±0.1	8.00^{b}±0.01	11.71^{b}±0.0	4.60^{e}±0.1	7.30^{c}±0.0	48.39^{e}±0.01
CC3	16.00^{d}±0.5	10.00^{a}±0.1	11.57^{c}±0.0	5.00^{c}±0.0	7.70^{a}±0.0	49.73^{d}±0.03
DD4	18.00^{c}±0.0	7.00^{c}±0.01	10.49^{e}±0.0	5.30^{d}±0.1	7.00^{d}±0.0	52.22^{c}±0.01
EE5	24.00^{a}±0.3	8.00^{b}±0.80	11.92^{a}±0.0	4.18^{f}±0.2	5.94^{e}±0.0	45.96^{f}±0.02
FF6	10.00^{f}±0.0	2.00^{d}±0.19	9.81^{f}±0.02	7.50^{a}±0.5	5.15^{f}±0.0	65.54^{a}±0.04

*Values are means ± standard deviation. Means with the same superscript in the same column are not significantly different ($p<0.05$). **Keys: AA1 =** 90:5:5 wheat-sorghum-African yam bean flour; **BB2 =** 80:10:10 wheat-sorghum-African yam bean flour; **CC3 =** 70:15:15 wheat-sorghum-African yam bean flour; **DD4 =** 60:20:20 wheat-sorghum-African yam bean flour; **EE5 =** 50:25:25 wheat-sorghum-African yam bean flour, **FF6 =** 100:0:0 wheat-sorghum-African yam bean flour.

Table 3: Mean scores for sensory evaluation of biscuits produced from blends of wheat, sorghum and African yam bean flours.

Samples	Taste	Colour	Texture	Aroma	OverallAcceptabili
AA1	7.95^{ab}±1.36	7.75^{b}±1.07	7.45^{b}±0.89	7.95^{ab}±1.39	7.75^{b}±0.92
BB2	7.85^{ab}±1.31	7.75^{b}±1.33	7.40^{b}±1.19	7.60^{b}±1.57	7.65^{b}±1.01
CC3	7.65^{b}±1.46	7.80^{b}±1.11	7.90^{ab}±1.21	7.55^{b}±1.47	7.73^{b}±1.04
DD4	7.50^{b}±1.10	7.70^{b}±1.30	7.40^{b}±1.31	7.85^{ab}±1.42	7.60^{b}±0.97
EE5	8.55^{a}±0.94	8.15^{ab}±1.0	8.40^{a}±1.14	8.40^{ab}±0.68	8.45^{a}±0.84
FF6	8.55^{a}±0.83	8.75^{a}±0.55	8.55^{a}±0.69	8.65^{a}±0.75	8.63^{a}±0.62

*Values are means ± standard deviation. Means with the same superscript in the same column are not significantly different ($p<0.05$). **Keys: AA1 =** 90:5:5 wheat-sorghum-African yam bean flour; **BB2 =** 80:10:10 wheat-sorghum-African yam bean flour; **CC3 =** 70:15:15 wheat-sorghum-African yam bean flour; **DD4 =** 60:20:20 wheat-sorghum-African yam bean flour; **EE5 =** 50:25:25 wheat-sorghum-African yam bean flour, **FF6 =** 100:0:0 wheat-sorghum-African yam bean flou

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