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Comparative Studies on the Proximate and Sensory Properties of Cookies Produced From Composite Flours of Wheat, Malted and Unmalted African Yam Bean

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Abstract— Cookies were produced from the composite flours of wheat, malted and unmalted African yam bean. The proximate and sensory evaluation of the cookies produced from blends of wheat flour, malted and unmalted African yam bean flour were determined. Malted and unmalted African yam bean flour were prepared and used at varying proportions in the production of cookies. The sensory qualities of cookies were evaluated using a 9- point Hedonic scale. The results showed that there were significant difference ($P<0.05$) in the colour, texture, aroma, taste and overall acceptability of the control samples and samples produced from 90% wheat flour and 10% malted AYB flour as well as the sample produced from 60% wheat flour and 40% unmalted AYB flour. These three samples were then subjected to proximate analysis using standard methods. The result revealed that there were significant difference in the moisture, ash, fats, protein, fiber and carbohydrate content of the samples which ranged from 6.00-12.00%, 5.00-6.00%, 5.03-9.00%, 13.43-22.60%, 6.50-14.00% and 42.50-63.39 respectively. The sample produced from 60% wheat flour and 40% unmalted AYB flour had the highest protein percentage (22.60) and ash (6.00) content while the sample produced from 90% wheat flour and 10% malted AYB flour had the least fat (5.03%), protein (13.43%) and fiber content (6.50%). The nutrient composition and sensory properties of wheat-African yam bean cookies showed that African yam bean flour (malted and unmalted) could be used as a partial substitute for wheat flour, thus providing an alternative means of diversifying the use of non-wheat flour.

Keywords: cookies, proximate composition, sensory evaluation, wheat flour, malted, unmalted and African yam bean flour.

I. INTRODUCTION

Cookies are one of the popular cereal foods, consumed in Nigeria. They are ready to eat, convenient and inexpensive food products, containing digestive and dietary principles of vital importance [9]. They are nutritive snacks produced from unpalatable dough that is transformed into appetizing products through the application of heat in the oven [13]. [10] noted that the nutritional content of cookies varies with the type of flour used.

The major source of flour for baked products such as cookies, cakes, bread and chinchin is wheat flour [14]. Wheat flour as the major ingredient for bakery products has dominated other potential sources of flour for bakery products. However, the high cost of wheat flour has led to a rise in the cost of bakery products in Nigeria and indeed other countries in Sub-Sahara Africa [5]. This has necessitated research efforts towards development of composite flours involving partial substitution of wheat flour with those from locally available vegetable crops (e.g. African yam bean) in developing countries, especially Nigeria [15].

Composite flours are mixtures of different vegetable flours rich in starch, protein, and/or other nutrients with or without wheat flour[14]. Several institutions, including the Food and Agriculture Organization (FAO), have been involved in research designed to find ways of partially substituting wheat flour with those from other sources or replacing wheat altogether. The technology of composite flours represents an interesting option for the management of costs associated with importation of wheat flour in developing countries like Nigeria where wheat is not cultivated for climatic reasons [16]. With the constant increase in the consumption of biscuits and other baked products in many developing countries, coupled with ever-growing urban populations, the composite flour/baked product technology could be very useful [15].

African Yam Bean (AYB) botanically known as *Sphenostylis stenocarpa* (Hochsts. Ex A. Rich) is an underutilized grain legume in Nigeria[9]. It is an important legume in Africa, a lesser known legume of the tropical and sub-tropical areas of the world which has attracted research in recent times [3]. The legume is very rich in protein, carbohydrate, vitamins and minerals [8]. As reported in the study of [12], the protein of African yam bean is made up of over 32 percent essential amino acids,

with lysine and leucine being predominant. African yam bean seeds can be roasted and eaten with palm kernel as snacks or boiled and eaten with local seasoning, starchy root crops and fruits[4]. African yam bean seeds can also be processed into flour which can be used for the production of bakery and confectionary products such as breads, biscuits, cookies, doughnuts, pie crust and cakes [12].This legume has been reported to be of importance in the management of chronic diseases like diabetes, hypertension, and cardiovascular diseases because of its high dietary fibre content [9].

Malting process is a way to promote changes in the biochemical, sensorial and nutritional characteristics of cereal and legume grains [14]. Food processing technologies can contribute to the alleviation of micronutrient deficiencies; one technique is malting which is widely used in legumes and cereals to increase their palatability and nutritional value, particularly through the breakdown of certain anti-nutrients such as phytate and protease inhibitors[2]. Process operations that reduce the level of anti-nutritional factors and minimize the losses of micronutrients are of interest to food processors; biological processes such as malting have the potential to improve the nutrient availability in foods.

Research on the use of vegetable flours as partial substitutes for wheat in the production of baked products has been attributed to efforts being made at promoting cost effectiveness and utilization of local crops as a result of huge foreign exchange that is associated with wheat importation[16]. This has resulted in the need to source for locally available and underutilized crops such as African yam bean (*Sphenostylis stenocarpa*) in the production of flours to be used as partial substitutes for wheat in bakery manufacturing. This would help drive down cost, enhance affordability by low-income populations and improve the nutritive value of baked products.

The present study is therefore aimed at investigating the feasibility of producing acceptable biscuit from malted and unmalted African yam bean with a view of promoting further utilization of the vegetable crop in the production of baked products in developing countries such as Nigeria.

II. METHODOLOGY

Two kilograms of African yam bean seeds, two kilograms of multipurpose wheat and other baking materials such as margarine, baking powder, egg, vanilla flavor and sugar were purchased from Eke Ekwuluobia market in Aguata Local Government Area of Anambra State and were taken to the Food Processing Laboratory of Food Technology Department, Federal Polytechnic Oko for further processing.

Sample Preparation

Production of Unmalted African Yam Bean Flour

The method described by [10] was used in production of unmalted African yam bean flour with slight modification. The White African yam bean seeds were sorted and soaked in cold water for 8 hours to loosen the seed coats. The seeds were rasped between palms and the loosened testa was removed by floatation in water. The dehulled seeds were dried using cabinet dryer at 70^{o}Cfor 8 hours and ground into flour which was later sieved to obtain fine flour. The flour obtained was packaged in an airtight container prior to further use.

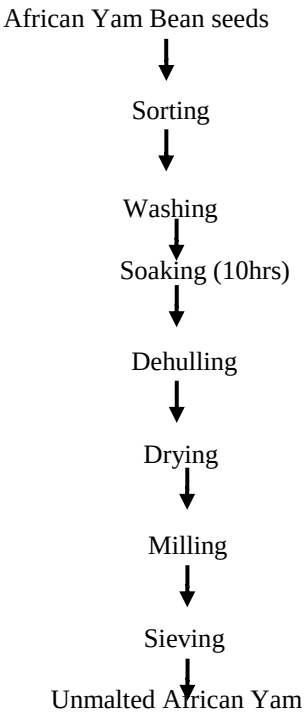

Fig.1: Flow chart for the production of unmalted African yam bean flour

Production of Malted African Yam Bean Flour

The malted African yam bean flour was prepared according to the method of[12]. During preparation, one kilogramme (1kg) of African yam bean seeds which were free from dirt and other foreign particles such as stones, sticks and leaves were thoroughly cleaned and soaked in 3 litres of potable water at room temperature (30 ± 2^{o}C) for 48 h with occasional change of soak water at intervals of 8 h to prevent microbial fermentation. The soaked seeds were drained, rinsed and spread on wet jute bag and allowed to sprout at ambient temperature for 96 h. During this period, the seeds were sprinkled with water at intervals of 6 h to facilitate germination. The growth of the sprouted seeds was terminated by drying the seeds in a cabinet dryer at 70^{o}C for 24 h with occasional stirring of the seeds at intervals of 30 min to ensure uniform drying. The dried seeds were cleaned manually and rubbed in between palms to remove the sprouts and the hulls. The dehulled seeds were milled in a locally fabricated attrition mill and sieved. The flour produced was packaged in an airtight plastic container, labeled and stored in a freezer until needed for further use.

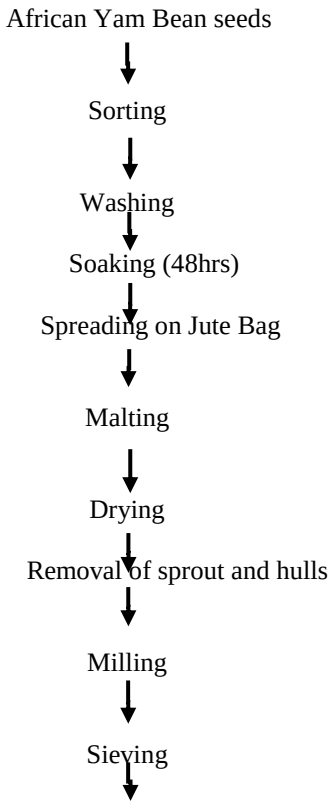

Fig. 2: Flow chart for the production of malted African yam bean flour

Formulation of Composite Flour

Wheat flour was blended with malted and unmalted African yam bean in the following proportion: 90:10, 80:20, 70:30, 60:40 and 50:50 wheat and malted African yam bean flour as well as 90:10, 80:20, 70:30, 60:40 and 50:50 wheat and unmalted African yam bean flour while 100% wheat flour served as the control.

Production of cookies

The cookies were prepared according to the method of[12]. The recipe used for the preparation of cookies contained 100% flour, 40% sugar, 80% fat, 2% baking powder, 2% salt, 5% beaten egg and 5% vanilla flavour. During preparation, the flour, sugar, baking powder and salt were hand mixed in a plastic bowl. This was followed by the addition of fat and further mixing by hand until a bread crumb-like mixture was obtained. The mixture was transferred into the food processor (Homeluck). The beaten egg and vanilla flavour were then added and the mixture was mixed thoroughly at medium speed for 5 minutes to obtain the dough. The dough was manually rolled out on a flat and smooth floured board into sheets of uniform thickness of 4cm and cut with a circular cookie cutter with diameter of 4cm. The cut doughs were transferred into baking trays lined with grease – proof paper and baked at 180^0C for 20 min in a domestic oven. Thereafter, the cookies were cooled at room temperature (30 ± 2^0C) and divided into two (2) lots. The first lot was subjected to sensory evaluation after 24 h. The second lot was milled and used for chemical analyses.

Proximate Analysis

The proximate analysis of the biscuit samples was carried out using the analytical methods of [1].

Sensory Evaluation

The cookies produced from the composite flour were subjected to sensory evaluation and this was done by coding all the samples and serving them to twenty panelists that were familiar with assessment of bakery products. The biscuit samples were evaluated for sensory parameters which are texture, taste, colour, flavour, aftertaste, mouth feel and general acceptability using the scoring text as described by [6]. The responses were scored on a nine point hedonic scale ranging from 1 (dislike extremely) to 9 (like extremely).

Statistical analysis

The data generated was subjected to Analysis of Variance (ANOVA) using version 21 of the software while the means will be separated using Duncan Multiple range test at 95% confidence test.

III. RESULTS AND DISCUSSION

Table 1: Sensory evaluation of cookies produced from blends of flour, malted and unmalted African yam bean flour.

Samples	Color	Texture	Aroma	Taste	Acceptabilit
AY1	$8.10^{a}\pm1.10$	$7.70^{a}\pm1.33$	$6.30^{a}\pm1.88$	$6.90^{a}\pm2.64$	$7.22^{a}\pm1.36$
AY2	$6.80^{a}\pm1.47$	$6.10^{b}\pm1.19$	$5.60^{ab}\pm0.96$	$6.10^{ab}\pm2.02$	$6.17^{ab}\pm1.10$
AY3	$5.70^{b}\pm1.41$	$5.40^{b}\pm1.64$	$5.10^{ab}\pm1.19$	$5.50^{ab}\pm1.50$	$5.45^{b}\pm0.91$
AY4	$5.80^{b}\pm2.04$	$5.50^{b}\pm1.95$	$4.30^{b}\pm1.94$	$5.40^{ab}\pm1.17$	$5.27^{b}\pm1.07$
AY5	$6.10^{b}\pm2.13$	$5.10^{b}\pm2.42$	$5.30^{ab}\pm1.88$	$5.10^{ab}\pm1.79$	$5.35^{b}\pm1.90$
AY6	$6.20^{b}\pm2.09$	$5.60^{b}\pm1.34$	$5.00^{ab}\pm1.41$	$5.60^{ab}\pm1.64$	$5.60^{b}\pm1.60$
UM1	$5.90^{b}\pm1.85$	$5.40^{b}\pm1.64$	$4.90^{ab}\pm2.13$	$5.40^{ab}\pm2.11$	$5.40^{b}\pm1.60$
UM2	$6.40^{ab}\pm1.67$	$5.20^{b}\pm1.13$	$4.60^{ab}\pm1.77$	$5.10^{ab}\pm1.44$	$5.20^{b}\pm1.79$
UM3	$5.80^{b}\pm2.09$	$5.40^{b}\pm2.01$	$4.60^{ab}\pm2.17$	$5.00^{b}\pm2.05$	$5.75^{b}\pm1.95$
UM4	$5.30^{b}\pm2.49$	$5.30^{b}\pm2.16$	$4.40^{b}\pm1.89$	$4.60^{ab}\pm2.11$	$5.45^{b}\pm0.89$
UM5	$6.30^{ab}\pm1.76$	$5.60^{b}\pm1.77$	$5.40^{ab}\pm1.50$	$5.30^{ab}\pm1.05$	$8.10^{a}\pm1.10$
UM6	$7.00^{ab}\pm1.49$	$5.50^{b}\pm1.64$	$4.60^{ab}\pm1.57$	$5.00^{b}\pm1.05$	$8.10^{a}\pm1.10$

*Means with the same superscript in the same column are significantly different at P<0.05

Key:

AY1: 100% wheat: 0% malted AYB ;**AY2**: 90% wheat: 10% malted AYB

AY3: 80% wheat: 20% malted AYB; **AY4**: 70% wheat: 30% malted AYB

AY5: 60% wheat: 40% malted AYB;**AY6**: 50% wheat: 50% malted AYB

UM1:100% wheat: 0% unmalted AYB;**UM2**: 90% wheat: 10% unmalted AYB

UM3: 80% wheat: 20% unmalted AYB;**UM4**: 70% wheat: 30% unmalted AYB

UM5: 60% wheat: 40% unmalted AYB;**UM6**: 50% wheat: 50% unmalted AYB

The mean score of the sensory evaluation of cookies produced from blends of malted and unmalted AYB is shown in Table 1.There was significant difference (P<0.05) in the colour of all the samples enriched with either malted flour or unmalted AYB flour. The mean scores for colour ranged from 5.30 in sample UM4 (70% wheat: 30% unmalted AYB flour) to 8.1 in sample AY1 (100% wheat: 0% unmalted AYB flour). The colours of the control sample (AY1) and UM6 sample (50% wheat: 50% unmalted AYB flour) were the most preferred (7.00) for the cookies produced from unmalted AYB flour, while that of sample AY2 (90%wheat: 10% malted AYB) was the most preferred for cookies produced from malted AYB flour. The texture of all the composite cookies were statically the same (P>0.05) but were significantly different (P<0.05) from the control sample. The control sample AY1 (100% wheat: 0% malted AYB) had a mean score of 7.70 while the composite cookies had values ranging from 5.10-6.10. This implies that inclusion of both malted and unmalted African yam bean flour in the formulated cookies reduced the expected texture of the cookies. This result is not in agreement with the findings of [12] who reported slight decrease in the texture of cookies produced from composite flours of wheat and African yam bean. The varied result may be due to the differences in the processing methods used in the preparation of African bean flour.

There was significant difference (P<0.05) in the aroma of the cookies sample. The aroma of the control sample is the most preferred with a mean score of 6.30 closely followed by that of AY2 (90% wheat: 10% malted AYB) and then UM5 (60% wheat: 40 unmalted AYB) at 5.6 and 5.4 respectively. It was observed that the scores for aroma of the sample decreased with increasing substitution of wheat with both malted and unmalted African yam bean. The aroma of cookies enriched with unmalted African yam bean were all disliked except for sample UM5 (60% wheat: 40% unmalted AYB) was neither liked or disliked according to 9- Hedonic scale rating [6], [10] reported similar decrease in the wheat flour as the level of substitution with AYB flour decreased.

The taste of the content of sample significantly differed (P<0.05) from those samples with a mean score of 6.90.

The overall acceptability results showed that the cookies produced from 90% wheat flour and 10% malted African yam bean (AY2) was acceptable and competed favorably with the control sample. The entire samples produced from wheat and unmalted AYB flour was all disliked except for sample UM5 (60% wheat: 40% unmalted AYB) which was slightly liked. Because of the level of preference placed on sample AY1 (100% wheat: 0% malted AYB), AY2 (90% wheat: 10% malted AYB) and UM5 (60% wheat: 40% unmalted AYB), they were selected for chemical analysis in other to ascertain the effect of inclusion of both malted and unmalted AYB flour on the proximate composition of cookies.

Table 2: Proximate composition of cookies produced from blends of wheat, malted and unmalted African yam bean flour

sample	moisture	ash	fat	Protein	fiber	carbohydrate
AY1	8.00^{b}±0.00	5.00^{c}±0.00	9.00^{a}±0.00	16.72^{b}±0.01	14.00^{a}±0.00	47.29±0.01
AY2	6.00^{c}±0.01	5.50^{b}±0.50	5.03^{c}±0.67	13.43^{c}±0.11	6.50^{c}±0.01	63.59±0.10
UM5	12.00^{a}±0.50	6.00^{a}±0.06	6.00^{b}±0.00	22.60^{a}±0.01	11.50^{d}±0.50	42.50±0.50

***Means are values of triplicate determination. Means with different superscript in the same column are significantly different at p<0.05**

Key:

AY1: 100% wheat: 0% malted AYB flour

AY2: 90% wheat: 10% malted AYB flour

UM5: 60% wheat: 40% unmalted AYB flour.

Table 2 shows the proximate composition of cookies produced from composite flours of wheat, malted and unmalted African yam bean. The moisture content of sample UM5 (60% wheat: 40% unmalted AYB flour) was significantly higher (P<0.05) than those of sample AY1(100% wheat: 0% malted AYB) and AY2 (90% wheat: 10% malted AYB). The difference in these values could be associated to the level of environmental factors, drying and baking temperature, experimental methods used. The high moisture content of UM5 (60% wheat: 40% unmalted AYB) may affect the shelf stability of the cookies as moisture has been implicated to promote microbial encroachment and spoilage.

The ash content of the cookies sample ranged from 5.00% and 6.00% with sample AY1 (100% wheat: 0% malted AYB) having the least value while sample UM5 (60% wheat: 40% unmalted AYB) had the highest value. The result showed that a significant difference (P<0.05) existed among the samples in terms of ash content. It was observed that inclusion of both malted and unmalted AYB flour slightly increased the ash content of the products. Similar observations were made by [12], who also reported slight increase (from 4.84% - 5.21%) in the ash content of cookies produced from blends of wheat and African yam bean flour. The ash content of the samples with African yam bean flour substitutions is an indication that the cookies may contain high level of mineral elements [17]. The fat content of the cookies significantly decreased (P<0.05) as wheat flour was substituted with both malted and unmalted AYB flour. The percentage fat content of the

sample was 5.03% for AY2 (90% wheat: 10% unmalted AYB). The result is not in agreement with the findings of [12] that reported slight increase in the ash content of cookies fortified with African yam bean protein and African yam bean flour respectively. The variations in these results may be attributed to differences in the methods, raw materials as well as species of AYB flour.

The protein content of the cookies sample were 13.43%, 16.72%, and 22.60 for AY2 (90% wheat: 10% malted AYB), AY1 (100% wheat: 0% malted AYB) and UM5 (60% wheat: 40% unmalted AY B) respectively and they significantly differed ($P< 0.05$) from one another. The percentage protein content obtained in this study is significantly higher ($P<0.05$) than the range of values (9.87% - 13.06%) reported in the study of [12] for cookies produced from blends of wheat and African yam bean. This difference could be attributed to the variations in the processing methods of African yam bean used. However the high protein content of sample UM5 (60% wheat: 40% unmalted AYB flour) showed that the addition of unmalted AYB flour resulted in increase in the protein content of the cookies. This observation is not in doubt because African yam bean had been reported to be a good source of protein. There was similar report on the increase in protein content of bakery products substituted with pigeon pea flour[4].

The fiber content of the cookies ranged from 6.50 – 14.00%. There was significant difference ($P<0.05$) in the fiber content when compared with the samples with both malted and unmalted AYB flour. The low fiber content of the sample with malted AYB flour is in line with the report of [7] who reported that malting and dehulling significantly reduced the fiber fractions of African yam bean flour. The percentage fiber obtained in this study is however was high. The carbohydrate content (6.359) of sample AY2 (90% wheat: 10% malted AYB flour) was significantly higher ($P<0.05$) when compared with those of sample AY1(100% wheat: 0% malted AYB flour) and UM5 (60% wheat: 40% unmalted AYB flour) which had values of 4.29% and 42.50 respectively. It was observed that the inclusion of unmalted AYB flour decreased the carbohydrate content and this agreed with the report of [12] that stated similar decrease in the carbohydrate content of cookies as the level of substitution of wheat flour with the AYB flour increased. The substitution of wheat flour with unmalted African yam bean flour in the production of cookies greatly improved their protein and ash content.

IV. CONCLUSION AND FUTURE SCOPE

The results showed that cookies can be produced by blending wheat flour with either malted and unmalted African yam bean flour. The sensory evaluation of cookies samples revealed that cookies produced from 90% wheat flour and 10% malted AYB flour as well as 60% wheat flour and 40% unmalted AYB flour were the most accepted in terms of color, texture, aroma, taste and overall acceptability and they competed favorably with the control sample (100% wheat flour cookies). The proximate analysis results showed that the addition of unmalted AYB flour in wheat flour significantly improved the protein and ash content of the biscuits when compared to the samples with malted AYB flour.

Further studies should be done to determine the vitamin, amino acid profile, minerals, anti nutrients as well as the storage stability of the wheat-African yam bean composite cookies.

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