Original Research Article

Production and Quality Assessment of Biscuit from Acha Flour Supplemented with Pigeon Pea

Abstract

This research work evaluates the production of biscuits from blends of acha and pigeon pea flour. Acha and pigeon pea flour were blended in the ratio 95:5, 90:10, 85:15, 80:20 and 100:0 (control) for the production of biscuits.Biscuits made from this blend were analyzed for proximate analysis, antinutrientcomposition, physical attributes, and sensory qualities. The moisture, protein, fat, crude fiber, ash, and carbohydrate content of the biscuits ranged from 7.87-9.84%, 7.36-8.14%, 21.99-26.33%, 0.39-0.59%, 0.87-1.24%, and 58.06-63.01%, respectively.The antinutrientcomposition ranged from 41.24-64.23% for tannin and 3.85-4.68% for phytate. The physical attributes of the biscuits ranged from 8.34-10.98 g, 0.56-0.85 cm, 4.21-7.21cm^3, 4.77-5.03, 5.99-8.59 for weight, thickness, volume, diameterand spread ratio, respectively. The sensory evaluation showed that the biscuit sample with the blend ratio of 95% and 5% (acha to pigeon pea flour) was the most acceptable because it gave the best colour, appearance, crispness and overall acceptability. The result shows that acceptable biscuits with improved nutritional attributes can be produced from the blend of acha and pigeon pea flour. This will eliminate or reduce the problems associated with protein-energy malnutrition, which is common in most local communities, reduce wheat importation thereby increasing the use of the most underutilized sources of flour in most developing countries.

Keywords: Antinutrient, composite flour, proximate composition, sensory evaluation and biscuit

1. INTRODUCTION

Biscuit is one of Nigeria's most commonly eaten non-fermented baked snacks [1]. The significant components of simple biscuits are wheat flour, water, sugar, fat, and eggs, which are blended into the dough with the addition of another compound if needed [2].Despite being an everyday diet in most cultures with relatively high carbohydrate, fat, and calorie content, the daily consumption of biscuits is not encouraged because of the low presence of protein, fiber, vitamins, and minerals [3]. Nevertheless, biscuits have a wide range of acceptance in terms of consumption by individuals under different age

groups across various rural and urban communities. Moreover, it can be consumed due to its good sensory attributes and relatively long shelf life [4].

Biscuit as a snack food tends to be used for protein fortification and substitute for diet improvements due to its general acceptance by various individuals regardless of their age bracket [5]. In addition, various researchers have demonstrated that an acceptable range of biscuits can be produced from a blend of non-wheat and wheat flours or different sources of flours other than wheat flours [6, 7]. However, over-reliance and dependency on wheat flour for the production of different snacks in the pastry industries in Nigeria has discouraged and prevented, to an extent, the use of other flour sources, such as flour from cereals and tuber crops sources for domestic use.

Recently, the collaborative efforts of the Nigerian government with various research institutes across the nation have improved the utilization of composite flour in producing different snacks such as biscuits and other seemingly related food products for example bread. This recent development has encouraged the exploration of other flour sources such as plantain, sweet potato, cassava flour, and other underutilized crops that can be used as flour sources other than wheat flour. Using this indigenous flour in the various baking industries across the nation will multiply the usage of local crops cultivated in Nigeria, reduce over-dependency on wheat flour and, most importantly, lower the cost of baked food products [8].

Acha (*Digitariaexilis*) is a grain crop that has historically been consumed whole as *tuwo, couscous, gwate,* acha*jollof*, and *kunun*acha[9]. Acha has high pentosane content (3.3%) and thus a high water absorption capacity, making it suitable for use in bakeries [10]. It is roughly 73% carbohydrates and high in micronutrients like iron and iodine (28.5 mg/100ml and 22.9 mg/100ml, respectively) [11].Acha is used as a health grain due to its gluten-free property and consumption as a whole food product[12]. It is abundant in methionine, therefore,it has low sugar concentration when consumed; this serves as an advantage to diabetics patients [13, 14].

Pigeon pea is indigenously available, has a low production cost, and is an underutilized grain legume both in the sub-tropics and tropics areas. Wide pigeon pea varieties have protein content varying from 23- 26% [15]. Pigeon pea is rich in minerals and fiber, and its protein content is comparable with other leguminous crops like cowpea and groundnut. Pigeon pea is well suited and adapted to Nigeria's climate for cultivation. However, its utilization in various food products has been limited mainly because its antinutrient or

phytochemicals make up the hard-to-cook phenomenon [16, 17]. Pigeon pea is desirous among the low-income earners in the urban area due to the taste, but it seems unaffordable due to the long cooking time and high fuel cost. Aside from the hard-to-cook phenomenon, pigeon pea seeds are challenging to dehull. Therefore, the seemingly tedious process of dehulling is a limiting factor in its utilization and processing [18].

Most underdeveloped and developing countries like Nigeria depend heavily on wheat flour to make bread, biscuits, cookies and other pastry products. For this reason, most of these countries are investigating the possibility of replacing or substituting wheat for other flour sources needed for making baked goods, wholly or partly with flour obtained from homegrown products. Flour from other sources that can be used as a wheat substitute or composite flour includes legumes, tubers, fruits, and cereals [19].However, in Nigeria, usingacha and pigeon pea flour in the production of baked goods is uncommon. This is because pigeon pea and acha flour are underutilized crops. Hence, this study aims to evaluate the quality attributes of biscuits produced from acha and pigeon pea flour blends.

2. MATERIALS AND METHODS

2.1 Samples Procurement

Acha(*Digitariaexilis*) grains were purchased from Nyanya market, Abuja, and pigeon pea (*Cajanuscajan*) was purchased at a local market in Bodija Ibadan, Oyo State. Margarine, sugar, salt, milk, egg, and baking powder were procured from Wazo market in Ogbomoso, Oyo State, Nigeria.

2.2 Sample Preparation

The method described by Adegoke[20]was used to obtain flour from acha seeds. Two kilograms of acha were washed and dried. Hammer mill was used to mill the dried acha, sieved, and then the flour was obtained through continuous sieving with a sieve aperture of 300 -400 µm. Pigeon pea (2 kg) was cleaned, sieved, washed and soaked in water to dehull and remove the shaft. Pigeon pea was oven dried in Genlab Cabinet dryer (Model DC 500, Serial number 12B154) at 55 °C for 12 hours, milled using Fritsch hammer mill (Serial number: 15.302/982) into flour, sieved at 450 µm aperture and pigeon flour was obtained at the end of this process.

2.3 Production of Biscuit

Five formulation blends were prepared using acha flour (AF) and pigeon pea flour (PPF) ratio. Ihekoronyeand Ngoddy[21]method was adopted with slight modification for biscuit production. The formulations containing sugar (60 g), baking powder (1%), milk (25g), flavouring (2g) and water (50ml) were

used to produce biscuits. The dry ingredients are first weighed and mixed before adding butter and then creamed. Water was added and mixedproperly until desired thickness is achieved. The batter was later cut into a circular shape using a biscuit cutter. The biscuits were baked at 180 ºC for 15 - 20 minutes, cooled and packed in polyethylene bags, sealed and kept at room temperature until used for chemical analysis, physical attributes and sensory evaluation.

2.4 Analyses

2.4.1 Proximate analysis

The proximate composition of samples were determined according to the method described by AOAC [22]. The soxlet extraction method was used to determine fat content in which hexane was used as the solvent. The protein content was determined by the Kjeldahl method. The crude fiber was determined by weighing approximately 0.5 g of the sample deffated in a tar-impregnated porcelain crucible. Then it is burned at 600 ℃ for about six hours in the oven until the fiber is obtained. Ash content was also determined by this method. Moisture content was determined by hot air oven method. Carbohydrate content was determined by sample difference, that is;

% carbohydrate content = (100 - % crude fiber + % protein + % fat + % ash + moisture content) (1)

2.4.2 Antinutritional factors

Folin-Denis spectrophotometric method was used to determine the tannin content [23]. The phytate content of the samples were determined according to the method of AOAC [22].

2.4.3 Physical attributes

An electronic scale was used to measure biscuit weight, and the mean of biscuit samples was recorded. The biscuit diameter was determined using [22]. Six biscuit samples are placed horizontally next to each other, and the diameter of the biscuit was measured with a digital caliper. The mean of six biscuit samples was obtained and used to indicate the diameter of the biscuit. The biscuit thickness was determined using the method described by Man *et al*. [24]. This method stacked six biscuit samples and the average thickness was obtained using a caliper. The average value obtained is used to specify the thickness of the biscuit. The biscuit spread ratio was defined as the mean diameter to mean thickness [25].

2.5 Sensory Evaluation

The biscuit samples were presented to 50 panelists from Food Engineering Department, LAUTECH, Ogbomoso for sensory evaluation in the laboratory. Individual panelists were randomly given six (6) samples of biscuits neatly arranged on a rectangular plastic tray. The biscuits were sealed separately in a pouch and were coded before the commencement of the sensory evaluation process. The panelists were required to evaluate sensory attributes such as colour, crispness, taste and the overall acceptability of the biscuits using a 9-point hedonic scale[26].

2.6 Statistical Analysis

Results obtained were analyzed using Statistical Package for the Social Sciences version 15 software (SPSS Inc., Chicago, IL, USA). The results were mean values of three individual replicates ± the standard deviation (SD). Data obtained were subjected to analysis of variance (ANOVA) and means separated with Duncan multiple range test at a significance level of $p<0.05$.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition

Proximate composition results of biscuits made from acha and pigeon pea flour are shown in Table 1. The moisture content ranged from 7.87 to 9.84%. The value of the results obtained in this study is similar to the results reported by Ayo and Andrew [27] on biscuits made from acha-date palm flour. The protein content of biscuits ranged from 5.36 to 8.14%. The protein content of the biscuits increased with the addition of pigeon pea flour. The increasecan be attributed to pigeon pea being a rich source of protein[16, 17].The highprotein content of the sample will be of great nutritionalimportance, especially in developing countries such asNigeriato curb the menace of protein-energymalnutrition.The fat content of the biscuit ranged from 2.19-2.63%.Addition of pigeon pea flour increased the fat content of the biscuit. This agrees with a report from Usman *et al*. [28]who reported increase in fat of biscuits produced from wheat flour and maize bran composite flour fortified with carrot extract. The low content of fat in biscuit produced indicates that the food can be recommended for people requiring low fat diet.

The ashcontent ranged from 0.87 to 1.24% in the biscuit.The ash in biscuits and any other baked food product indicates the presence of minerals in the food. The results obtained in this study for ash content were similar to those obtained by Usman *et al*. [28] on biscuit produced from carrot extract and cornmeal flour. Ash is an inorganic compound used as a mineral indicator in foods that contributes to the metabolic

activities of other compounds such as proteins, lipids, and carbohydrates [29].Carbohydrate content ranged from 58.06 to 63.01%. The results obtained for carbohydrates in this study were similar to the findings of Ufot*et al*. [30] on functional biscuits from whole wheat flour supplemented with acha and kidney bean flour. However, the samples have a significant difference ($p<0.05$). Carbohydrates are an excellent source of energy used in daily human activities. The carbohydrate content in these samples suggests that the products may bea prominent energy source.

Table 1. Proximate composition of biscuits produced from acha-pigeon pea flour blends

Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fibre (%)	CHO (%)
A	7.87±1.00^{c}	7.36±1.00^{a}	2.19±0.18^{a}	0.87±1.00^{a}	0.59±1.00^{d}	61.32±0.72^{c}
B	8.94±0.15^{a}	7.59±1.00^{b}	2.28±0.18^{a}	1.00±1.00^{b}	0.54±1.00^{c}	63.01±0.95^{d}
C	8.99±0.15^{a}	7.74±0.11^{c}	2.28±1.77^{a}	1.10±1.00^{c}	0.47±0.13^{b}	62.97±0.95^{d}
D	9.38±0.15^{a}	7.82±0.11^{c}	2.46±1.00^{b}	1.20±0.13^{d}	0.43±0.17^{ab}	60.49±0.72^{b}
E	9.84±0.22^{b}	8.14±0.81^{d}	2.63±0.18^{c}	1.24±0.13^{d}	0.39±0.17^{a}	58.06±1.00^{a}

Means with the same superscript within the same column are not significantly different ($p>0.05$).A= 100% Acha flour; B= 95% Acha flour + 5% pigeon pea flour; C= 90% Acha flour + 10% pigeon pea flour; D= 85% Acha flour + 15% pigeon pea flour; E= 80% Acha flour + 200% pigeon pea flour

3.2 Antinutritional Composition of Biscuit

Table 2 shows the antinutrientsproperties of biscuits. The antinutrient contents of the sample ranged from 4.24 to 6.82 mg/100 g, 3.85 to 4.68 mg/100 g for tannin and phytate, respectively. It was discovered that when pigeon pea flour was added, the antinutritional value increased. However, the levels of these antinutrients in all the samples were relatively low, suggesting that they may not interfere with the bioavailability of essential nutrients in flours.Tannin has astringent properties that aid in the healing of wounds and inflamed mucous membranes [31] and its antioxidative properties can inhibit the generation of superoxide radicals [32].The maximum permissible dose of phytate in the body, according to Bushway[33] is between 250 and 500 mg/100g. Thus, biscuit produced from achaand pigeon pea flour is safe for consumption.

Table 2. Antinutritional properties of biscuit from blends of acha and pigeon pea flour

Sample	Tannin (mg/100g)	Phytate (mg/100g)
A	4.24±1.00^{a}	3.85±1.00^{a}
B	5.46±1.00^{b}	4.09±0.12^{b}
C	5.63±1.00^{c}	4.11±0.12^{b}
D	6.23±1.00^{d}	4.26±0.12^{b}
E	6.82±1.00^{e}	4.68±1.00^{c}

Means with the same superscript within the same column are not significantly different ($p>0.05$).
*Symbols A, B, C, D and E are as defined in Table 1

3.3 Physical Attributes of Biscuit

The results of the physical attributes of the biscuits are shown in Table 3. The physical attributes values of the biscuits varied between 8.34 to 10.98 g, 0.56 to 0.85 cm, 4.77 to 5.03 cm, 5.99 to 8.59 for weight, thickness, diameter and spread ratio, respectively. The increase observed in the physical attributes of the biscuit samples could result from the pigeon pea flour's higher fat and starch content. Ayo *et al*. [34] and Okaka and Isieh[35] reported similar observationson biscuits produced from acha-wheat biscuits supplemented with soybean flourand cowpea-wheat biscuits. The spread ratio decreased with the addition of pigeon pea flour. The presence of pigeon pea flour showed more effect on the spread ratio of the biscuits.

Table 3. Physical attribute of biscuit from blends of acha and pigeon pea flour

Sample	Weight (g)	Thickness (cm)	Diameter (cm)	Spread ratio
A	8.34±0.014 ^{a}	0.56±0.014 ^{a}	4.77±0.021 ^{a}	8.59±0.021 ^{f}
B	9.34±0.014 ^{b}	0.70±0.021 ^{b}	4.87±0.035 ^{b}	7.00±0.000 ^{e}
C	10.04±0.007 ^{c}	0.76±0.014 ^{c}	4.94±0.021 ^{c}	6.58±0.021 ^{d}
D	10.38±0.021 ^{d}	0.78±0.021 ^{c}	4.99±0.007 ^{d}	6.31±0.014 ^{c}
E	10.98±0.014 ^{e}	0.85±0.007 ^{d}	5.03±0.007 ^{d}	5.99±0.007 ^{b}

Means with the same superscript within the same column are not significantly different (p>0.05).
*Symbols A, B, C, D and E are as defined in Table 1

3.4 Sensory Attributes

The results of the sensory evaluation of biscuits are shown in Table 4. The assessment of sensory attributes of any food product plays a vital role in its development as it is used to assess the general acceptability of a food product. Table 4 indicates that the average scores of the sensory attributes taste, sweetness, crispiness, shape, colour and flavour varied between samples. Taste and appearance are among the most commonly used sensory parameters to assess the end consumer's overall acceptability of any finished food product. The mean scores for the biscuit flavour ranged from 5.10 to 7.96, and they differed significantly ($p<0.05$). The appearance of the biscuits has an average score ranging between 4.2 and 8.0 and was significantly different from ($p<0.05$). The average of the scores for the general acceptability varied from 4.0 and 8.0, and they were significantly different ($p<0.05$) from each other.Moreover, the addition of pigeon pea improved sensory characteristics of the product with the best overall acceptability in biscuits with sample A (100% acha and 0% pigeon pea) and sample B (95% acha and 5% pigeon pea). Therefore, the usage of acha and pigeon peaflour in production of biscuits can be recommended for targeting of nutritional and sensorial properties of this bakery product.

Table 4. Sensory evaluation of biscuit from acha and pigeon pea flour blends

Sample	Taste	Sweetness	Crunchiness	Appearance	Colour	Flavour	Overall acceptability
A	7.90^{c}	7.90^{c}	7.80^{c}	8.00^{d}	8.30^{d}	7.95^{b}	8.00^{c}
B	7.95^{c}	7.90^{c}	8.20^{c}	8.00^{d}	8.00^{d}	7.95^{d}	8.00^{c}
C	7.96^{cd}	7.80^{c}	7.00^{bc}	6.40^{bc}	7.10^{cd}	8.00^{ab}	7.00^{bc}
D	6.85^{cd}	6.40^{b}	5.60^{ab}	5.40^{ab}	7.10^{cd}	6.60^{ab}	5.80^{ab}
E	5.10^{a}	5.05^{a}	4.80^{a}	4.20^{ab}	5.25^{a}	5.15^{a}	4.00^{a}

Means with the same superscript within the same column are not significantly different (p>0.05).
*Symbols A, B, C, D and E are as defined in Table 1

4. CONCLUSIONS

The findings of this study indicated that composite flour from acha and pigeon pea could be used to make biscuits with improved nutritional attributes and characteristics. Biscuits produced from 95% of acha flour and 5% of pigeon pea flour were the most accepted by the panelists. As a result, production of biscuits from acha and pigeon pea flour blends should be encouraged to increase usage. It will also increase local farmers' income and reduce or eliminate the problem of protein-energy malnutrition, which is prevalent in most communities and developing countries, including Nigeria.

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