Haya: The Saudi Journal of Life Sciences (SJLS)
Scholars Middle East Publishers
Dubai, United Arab Emirates
Website: http://scholarsmepub.com/

ISSN 2415-623X (Print)
ISSN 2415-6221 (Online)

Nutritional and Physical Characteristics Evaluation of Biscuit from Fermented Bambara Nut and Wheat Flour

B.F. Olanipekun, O.O. Ola, O.E. Adelakun*, O.J. Oyelade and A.O. Abioye
Department of Food Science and Engineering, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria

Original Research Article

***Corresponding author**
O.E. Adelakun

Article History
Received: 07.08.2018
Accepted: 13.08.2018
Published: 30.08.2018

DOI:
10.21276/haya.2018.3.8.3

Abstract: Bambara nut (*Voandzeia subterrenea (L.*) Thouars) is a cheap source of leguminous protein with a good potential as substitute for relatively expensive animal protein, in several food products such as biscuits, particularly in developing countries. Biscuit was produced from blends of wheat flour and fermented bambara nut flour (l00:0, 90:10, 80:20, 70:30, 60:40 and 50:50) and was analysed. Proximate composition and protein content of biscuit produced from the flour mixes was higher than that produced with 100% wheat flour, while the moisture content ranged between 2.95 and 5.71%. The carbohydrate components and reducing sugar were in the ranges of 60.29 and 64.99%, and 2.74 and 4.43%, respectively. Sensory data indicated that the fermented bambara nut biscuit with up to 30% were acceptable. Thickness, diameter and spread ratio of the biscuit ranged from 230.33 -285.67mm, 29.00 - 36.67 mm and 61.70 -89.19%, respectively. Consequently, the potentials of fermented bambara nut in biscuit production was established thereby providing alternative composite flour in biscuit production.

Keywords: Fermented bambara nut, biscuit, nutritional quality, composite flours.

INTRODUCTION

Biscuits can be distinguished from other baked products in relation to its low moisture content of usually less than 5%, making them to have a low risk of microbial spoilage and thus long shelf life [1]. Wheat flour which is the main ingredient used to produce biscuit but cannot be grown commercially in many regions of the world due to agronomic reasons. Therefore, the relevant industries survive by utilizing available local grains which can be substituted with wheat without adversely altering the quality of the product.

Composite flour can be defined as a mixture of several flours obtained from roots and tubers, cereals, including legumes with or without the addition of wheat flour. Composite flour has the added advantage of improving the nutrient value of biscuits and other bakery products especially when cereals are blended with legumes such as Bambara nut. This can be particularly useful in countries where malnutrition poses a serious problem among children. Composite flours are advantageous because it supplement the deficiencies.

Fermentation is an age long process of processing cereals and legumes which not only modifies some physical characteristics of the grains but also increases the levels of nutrients, digestibility and bioavailability as well as decreases the level of anti-nutrients [2]. Fermentation process has helped in the development of several food products including biscuits, with an improvement in flavours, textures and nutritive properties.

Bambara nuts are edible seed from the *Leguminosae* family [3]. It is a promising crop which needs more awareness. Bambara nut is high in protein and thus play important role in human nutrition which makes the crop an excellent source of supplementing dietary proteins. A detailed study shows that it contains 20-26% crude protein, carbohydrate (63%), fat (6.3%) with relatively high proportions of lysine (6.6%) and methionine (1.3%) [4]. Bambara nut is highly nutritive in vitamin and mineral contents like iron, phosphorous and calcium. It also has a high content of crude fibre and high level of sulphur containing amino acids which are limited in cereals [5]. However, bambara nut are grossly underutilized. Therefore, with the ban on importation of wheat used for baking in confectionery industries in some developing countries, it is hoped that indigenous crops such as bambara nut will be used as substitutes for imported ones. This work therefore produced biscuit from flour blends of wheat-fermented bambara nut with high nutritional quality while discovering the optimum level of bambara nut flour substitution for such.

MATERIALS AND METHODS

Materials used for cookie preparation

Bambara nuts *(Voandzeia Subterranean (L)* thouars), Golden Penny wheat flour (Nigeria Brand) and other ingredients used in preparation of biscuits were obtained from Ogbomoso, Nigeria.

METHODS

Preparation of the flour samples

Bambara nut were fermented using the method of Olanipekun *et al.*, [6]. The nuts were cleaned and washed prior to steeping in water for 24 h, and thereafter dehulled. The steeped beans were boiled in the steeped water for 15 mins, drained and spread out to dry a little at room temperature. Dehulled bambara nut were poured into perforated polythene bag and an appropriate volume of 2 ml of spore suspension of *R. oligosporous* were carefully added, thoroughly mixed and tightly sealed. They were incubated at 32 °C for periods of time ranging between 0 and 48 h at regular intervals of 24 h. The seeds were drained and dried in an oven maintained at 55 °C for 24 h, cooled and finely ground using hammer mill to obtain the flour. The flour samples were kept in airtight containers until needed for analysis

Biscuit preparation

The flour used for biscuit production were from blends of fermented bambara nut flour and wheat flour using 0, 10, 20, 30, 40 and 50% bambara nut flour, respectively. The 100% wheat flour biscuit was used as the control sample. The method used for the preparation of dough was the creaming method where fat and sugar were creamed together using electric mixer at medium speed for 2 min [7]. Baking powder and milk were added and mixed until dough was well mixed. The dough was manually kneaded to ensure uniformity. The dough was rolled using a roller and cut into round shapes using a cutter. Shaped dough pieces were placed into a greased pan and baked in the oven at 200°C for 15min. The baked biscuits were placed on a cooling rack for 30 min to cool before packaging.

Analyses

Chemical analyses of biscuit

Protein content was determined using the micro - Kjeldahl method as described by AOAC [8]. Reducing sugar and moisture contents were also determined according to the methods described by AACC [9]. Analyses were performed in triplicates.

Sensory evaluation

Sensory evaluation of biscuit samples from various flour blends was conducted using a 25 member semi-trained panelists drawn from the staff of Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Biscuits were evaluated for colour, crispiness, crumbliness, hardness, aroma, taste and overall acceptability using a nine-point hedonic scale [10].

Physical Analysis

Diameter and thickness were measured with a vernier calliper at two different places in each biscuit and the mean was determined [11]. The spread ratio was calculated as the quotient of diameter of biscuit and height of biscuit [9].

Statistical Analysis

The data obtained from study and sensory evaluation was subjected to descriptive and inferential statistics, and significance difference at $p<0.05$ examined.

RESULTS AND DISCUSSION

Chemical components of wheat/fermented bambara nut biscuit

The result of the chemical analysis of the biscuit samples are shown in Table-1. The protein ranged from 4.61 - 8.00%. Sample B_5 (50:50 of wheat flour to fermented bambara nut mixes) had the highest compared to the control sample with the lowest protein content. The result of the product reveals that protein increased due to fermentation process of bambara nut as reported [12, 13]. The moisture content of the biscuit samples ranged from 2.95 - 5.71%. Sample A had the highest moisture content while sample C_5 had the least value. This corroborates with the report of Ayo *et al*., [11] in which the moisture content decreased as substitution level increases. Although there was a significant difference between moisture content of the samples ($p<0.05$), the initial moisture contents in all samples were within the acceptable level. The reducing sugar content of the biscuit ranged from 2.74 -4.43%. Sample B_2 had the highest while sample C_3 had the lowest. There is a slightly increase in reducing sugar during fermentation. The increased level of reducing sugar is a reflection of the activities of amylase and sucrose in the fermenting seed [14]. Carbohydrate content varied from 60.29 - 64.99%. Decreasing trend of carbohydrate content as the substitution level increases is in accordance with the findings of Okaka *et al*., [15] as well as Okoye and Obi [16]. Biscuits are generally high in sugar and low in moisture. These factors inhibit starch gelatinization which has little contribution to the structure of the finished product.

Table-1: Chemical components of wheat/fermented bambara nut biscuit

Sample	Protein (%)	Reducing sugar (%)	Carbohydrate (%)	Moisture (%)
A	4.61±0.21^{a}	2.93±1.00^{c}	60.50±2.33^{d}	5.71±0.18^{i}
B_1	5.96±0.52^{d}	3.72±1.00^{g}	63.91± 3.18^{i}	3.44±0.21^{e}
B_2	6.30±0.10^{f}	4.43±0.84^{j}	62.62±1.78^{g}	3.09±0.15^{c}
B_3	7.17±0.33^{j}	4.43±0.84^{i}	62.07±2.45^{f}	4.02±0.88^{f}
B_4	6.63±0.41^{j}	3.33±1.00^{e}	61.99±1.89^{e}	4.60±1.02^{h}
B_5	8.00±0.48^{k}	3.22±0.68^{d}	61.24±1.41^{d}	4.96±0.29^{j}
C_1	5.51±0.77^{b}	3.53±0.08^{f}	64.99±1.49^{k}	3.01±0.58^{b}
C_2	6.57±0.24^{h}	3.23±0.68^{d}	63.93±1.00^{j}	2.95±0.14^{a}
C_3	6.21±0.10^{e}	2.74±0.02^{a}	63.15±2.00^{h}	3.44±0.27^{e}
C_4	5.70±0.75^{c}	2.81±0.35^{b}	60.74±2.31^{c}	4.09±0.12^{g}
C_5	6.44± 0.93^{g}	3.79±0.11^{h}	60.29±2.65^{a}	3.19±0.54^{d}

All values are means of triplicate determinations ± standard deviation (SD). All values with different Superscripts in the same column are significantly different at $p< 0.05$.

Key: Sample A = 100% wheat flour
Sample B_1 = 90:10%, wheat flour + 24h fermented bambara nut flour
Sample B_2 = 80:20%, wheat flour + 24h fermented bambara nut flour
Sample B_3= 70:30%, wheat flour + 24h fermented bambara nut flour
Sample B_4 = 60:40%, wheat flour + 24h fermented bambara nut flour
Sample B_5 = 50:50%, wheat flour + 24h fermented bambara nut flour
Sample C_1 = 90:10%, wheat flour + 48h fermented bambara nut flour
Sample C_2 = 80:20%, wheat flour + 48h fermented bambara nut flour
Sample C_3 = 70:30%, wheat flour + 48h fermented bambara nut flour
Sample C_4 = 60:40%, wheat flour + 48h fermented bambara nut flour
Sample C_5 = 50:50%, wheat flour + 48h fermented bambara nut flour

Sensory evaluation of biscuits prepared from composite flour

The result of the sensory evaluation is shown in Table-2. Mean quality score of the colour of the biscuits ranged from 3.00 - 6.60. It is evident from the results that biscuits prepared from sample A has the highest value of 6.60 while biscuits prepared from C_5 has the lowest value of 3.00. Judges disliked the biscuits prepared from C_5 with respect to colour because the seed used for the production of flour were fermented for a longer period of time. Darkness in colour of the biscuits was observed as the level of the supplementation of the bambara nut flour increased in the wheat flour. From the result, Sample A (control) has the highest value (6.80) for the quality score of the biscuits compared to the biscuit produced from flour mixes. This could be attributed to the decreasing amount of gluten due to the decreasing levels of wheat flour in the mixtures. Gluten is known for the extensibility of the dough [8]. Based on aroma, the judges accepted biscuits from all the treatments of the composite flour containing bambara nut flour except sample C_5. This effect could be as a result of longer fermentation period leading to a noticed slight aroma of beany flavor. Since aroma is the main determining factor in consumers' acceptance of biscuit, it can be deduced that the biscuit is accepted up to 70% substitution with bambara nut.

Table-2: Sensory attributes of biscuits with bambara nut flour blend

Sample	Colour	Crispiness	Crumbliness	Aroma	Taste acceptability	Overall
A	6.60±0.35^{k}	6.80±0.21^{h}	6.90±0.82^{i}	6.60±0.29^{j}	6.70±0.36^{j}	6.70±0.47^{h}
Bi	5.30±0.80^{g}	6.30±0.47^{h}	6.20±1.00^{h}	5.90±0.44^{i}	6.10±0.67^{h}	5.60±0.39^{g}
B_2	5.20±0.41^{g}	5.20±0.28^{f}	5.70±0.34^{f}	5.70±0.18^{h}	5.80±1.00^{g}	5.60±0.39^{g}
B_3	4.90±0.15^{f}	4.70±0.29^{e}	4.80±0.11^{d}	5.30±0.09^{e}	5.10±0.25^{e}	5.50±0.31^{f}
B_4	6.50±1.01^{i}	5.70±0.33^{g}	5.40±0.19^{e}	5.00±0.39^{b}	4.90±0.81^{c}	5.40±0.84^{e}
B_5	5.50±0.29^{f}	5.20±0.41^{f}	5.80±0.23^{g}	5.50±0.72^{g}	5.40±0.13^{f}	5.40±0.15^{e}
C_1	3.80±0.13^{c}	4.10±0.93^{c}	3.50±0.41^{a}	5.00±0.17^{b}	5.00±0.74^{d}	4.80±0.65^{d}
C_2	3.10±0.42^{b}	4.70±0.57^{c}	3.50±0.41^{a}	5.40±1.00^{f}	4.00±0.42^{a}	4.20±0.44^{b}
C_3	4.80±0.38^{e}	4.40±1.20^{d}	4.40±0.25^{c}	5.20±0.44^{d}	4.90±1.00^{c}	4.80±0.35^{d}
C_4	4.00±0.22^{d}	3.40±1.00^{b}	4.00±0.70^{b}	5.10±0.37^{c}	4.20±1.00^{b}	4.30±0,29^{c}
C_5	3.00±0.17^{a}	2.90±0.30^{a}	3.50±0.41^{a}	2.20±0.13^{a}	4.00±0.42^{a}	4.00±0.25^{a}

The results show that supplementation significantly affected the overall acceptability of the biscuits. Maximum score (6.70) by biscuits prepared from sample A (control) while minimum scores (4.00) were recorded from the biscuits prepared from C_5. Biscuits prepared from C_5 were rejected by judges with

respect to overall acceptability. It could be recommended that up to 24 h fermentation period and 70% bambara nut flour be used in the substitution of wheat flour in the production of biscuits.

All values are means of triplicate determinations ± standard deviation (SD). All values with different superscripts in the same column are significantly different at $p< 0.05$.

Key: Sample A = 100% wheat flour
Sample B_1= 90:10%, wheat flour + 24h fermented bambara nut flour
Sample B_2 = 80:20%, wheat flour + 24h fermented bambara nut flour
Sample B_3= 70:30%, wheat flour + 24h fermented bambara nut flour
Sample B_4 = 60:40%, wheat flour + 24h fermented bambara nut flour
Sample B_5 = 50:50%, wheat flour + 24h fermented bambara nut flour
Sample C_1 = 90:10%, wheat flour + 48h fermented bambara nut flour
Sample C_2 = 80:20%, wheat flour + 48h fermented bambara nut flour
Sample C_3 = 70:30%, wheat flour + 48h fermented bambara nut flour
Sample C_4 = 60:40%, wheat flour + 48h fermented bambara nut flour
Sample C_5 = 50:50%, wheat flour + 48h fermented bambara nut flour

Physical evaluation of biscuits produced from wheat-bambara nut flour mixes

Physical characteristics of biscuits prepared from composite flour are shown in Table-3. Results showed that the thickness, diameter and spread ratio of the biscuits prepared from the composite flour varied significantly ($p <0.05$) between the treatments. Thickness and diameter of the biscuits showed gradual increase as the level of bambara nut flour replacement from samples B_1 - B_5 and C_1 – C_5. The finding is in accordance with the report of Agu *et al*., [17] on the quality characteristics of biscuit made from wheat and African breadfruit. The increase in diameter could be due to the reduction in gluten content (elasticity) with increase in bambara nut flour. The results showed that the spread factor gradually decrease as the level of bambara nut flour replacement increased. This can be attributed probably to the effects of composite flours that form aggregates with increased numbers of hydrophilic sites found within the oligosaccharides, polysaccharides and protein which compete for the limited free water in cookies dough [18]. These results obtained for the spread factor were in close agreement with Hailu [19] who reported that spread factor decreased with increasing level of potato flour supplementation.

Table-3: Physical characteristics of biscuit with different bambara nut flour content

Treatment	Thickness (mm)	Diameter (mm)	Spread factor
A	230.33±l.48^{a}	36.67±0.40^{j}	61.70±0.83^{a}
B_1	263.33±l.05^{d}	29.00±0.28^{a}	89.19±l.45^{j}
B_2	264.33±1.30^{f}	29.67±0.19^{b}	86.88±l.22^{h}
B_3	270.67±2.96^{h}	31.33±l.00^{d}	84.38±0.92^{f}
B_4	275.67±2.00^{i}	32.00±0.23^{e}	84.38±l.08^{f}
B_5	285.67±2.32^{i}	36.00±0.31^{i}	76.39±l.24^{d}
C_1	256.33±l.67^{b}	29.00±0.39^{a}	88.39±0.38^{i}
C_2	260.00±l.95^{c}	30.00±0.24^{c}	86.67±0.75^{g}
C_3	263.67±3.60^{e}	34.00±0.13^{f}	77.54±0.36^{e}
C_4	266.00±2.00^{g}	35.00±0.28^{g}	76.00±0.95^{c}
C_5	266.00±l.40^{g}	35.76±0.42^{h}	73.89±l.10^{b}

All values are means of triplicate determinations ± standard deviation (SD). All values with different superscripts in the same column are significantly different at $p< 0.05$.

Key: Sample A = 100% wheat flour
Sample B_1 = 90:10%, wheat flour + 24h fermented bambara nut flour
Sample B_2 = 80:20%, wheat flour + 24h fermented bambara nut flour
Sample B_3= 70:30%, wheat flour + 24h fermented bambara nut flour
Sample B_4 = 60:40%, wheat flour + 24h fermented bambara nut flour
Sample B_5 = 50:50%, wheat flour + 24h fermented bambara nut flour
Sample C_1 = 90:10%, wheat flour + 48h fermented bambara nut flour
Sample C_2 = 80:20%, wheat flour + 48h fermented bambara nut flour
Sample C_3 = 70:30%, wheat flour + 48h fermented bambara nut flour
Sample C_4 = 60:40%, wheat flour + 48h fermented bambara nut flour
Sample C_5 = 50:50%, wheat flour + 48h fermented bambara nut flour

CONCLUSION

This study has shown that fermentation process generally improved the nutritional quality of biscuit produced from the composite flour. The increasing trend in the protein content of the produced biscuits as the level of substitution increases could be used in eradicating malnutrition problem among children particularly in the developing countries. This study has also opened new possibilities of incorporating fermented bambara nut flour into starchy diets which will lead to expansion in the utilization of fermented bambara nut flour. Invariably, this could reduce the importation rate of wheat flour thereby increasing savings in foreign exchange for countries with favourable agronomic potentials for cultivation of bambara nut, but that still rely heavily on the importation of wheat.

REFERENCES

1. Zydenbos, S., Humphrey-Taylor, V. (2004). *Biscuits, Cookies, and Crackers*: Nature of the Products. Encyclopedia of Grain Science, Elsevier, Oxford, 307-312.
2. Onweluzo, J. C., & Nwabugwu, C. C. (2009). Fermentation of millet (Pennisetum americanum) and pigeon pea (Cajanus cajan) seeds for flour production: Effects on composition and selected functional properties. *Pakistan Journal of Nutrition*, *8*(6), 737-744.
3. Basu, S., Mayes, S., Davey, M., Roberts, J. A., Azam-Ali, S. N., Mithen, R., & Pasquet, R. S. (2007). Inheritance of 'domestication'traits in bambara groundnut (Vigna subterranea (L.) Verdc.). *Euphytica*, *157*(1-2), 59-68.
4. Mahala, A. G., & Mohammed, A. A. A. (2010). Nutritive evaluation of bambara groundnut (Vigna subterranean) pods, seeds and hull as animal feeds. *J Appl Sci Res*, *6*(5), 383-386.
5. Okpala, L. C., & Chinyelu, V. A. (2011). Physicochemical, nutritional and organoleptic evaluation of cookies from pigeon pea (Cajanus cajan) and cocoyam (Xanthosoma sp) flour blends. *African journal of food, agriculture, nutrition and development*, *11*(6).
6. Olanipekun, B. F., Otunola, E. T., Adelakun, O. E., & Oyelade, O. J. (2009). Effect of fermentation with Rhizopus oligosporus on some physico-chemical properties of starch extracts from soybean flour. *Food and chemical toxicology*, *47*(7), 1401-1405.
7. Nwosu, J. N. (2013). Production and evaluation of biscuits from blends of Bambara Groundnut (Vigna Subterranae) and Wheat (Triticum Eastrum) flours. *International journal of food and nutrition science*, *2*(1), 4-9.
8. Association of Official Analytical Chemists. (2005). *Official methods of analysis of the Association of Official Analytical Chemists* 18th Edition. (2). Association of Official Analytical Chemists.
9. American Association of Cereal Chemists. (2000). *Approved Methods of the American Association of Cereal Chemists*. American Association of Cereal Chemists.
10. Akinwande, B. A., Ade-Omowaye, B. I. O., Olaniyan, S. A., & Akintaro, O. O. (2008). Quality evaluation of ginger-flavoured soy-cassava biscuit. *Nutrition & Food Science*, *38*(5), 473-481.
11. Ayo, J. A., Ayo, V. A., Nkama, I., & Adewori, R. (2007). Physiochemical, In-Vitro Digestibility and Organoleptic Evaluation of" Acha" Wheat Biscuit Supplemented with Soybean Flour.
12. Uwaegbute, A. C., Iroegbu, C. U., & Eke, O. (2000). Chemical and sensory evaluation of germinated cowpeas (Vigna unguiculata) and their products. *Food Chemistry*, *68*(2), 141-146.
13. Oboh, G., Akindahunsi, A. A., & Oshodi, A. A. (2002). Nutrient and anti-nutrient contents of Aspergillus niger-fermented cassava products (flour and gari). *Journal of Food Composition and Analysis*, *15*(5), 617-622.
14. Omafuvbe, B. O, Shonukan, O. O., &. Abiose, S. H. (2000). Microbiology and Biochemical changes in the traditional fermentation of soybeans Dadawa a Nigerian Food Condiment. *Food Microbiology*, 17:467-474.
15. Okaka, J. C., Okoye, J. I., & Onuora, J. O. (2009). Biscuit making, functional, sensory and nutritional properties of high legume protein wheat flour-raw, cooked and toasted brown bean *(phaseolus vulgaris*). *Journal Science and Technology*,15: 61-77.
16. Okoye, J. I., & Obi, C. D. (2017). Chemical Composition and Sensory Properties of Wheat-African Yam Bean Composite Flour Cookies. *Discourse Journal of Agriculture and Food Sciences*, *5*(2), 21-27.
17. Agu, H. O., Ayo, J. A., Paul, A. M., & Folorunsho, F. (2007). Quality characteristics of biscuits made from wheat and African breadfruit (Treculia africana).
18. Hallén, E., İbanoğlu, Ş., & Ainsworth, P. (2004). Effect of fermented/germinated cowpea flour addition on the rheological and baking properties of wheat flour. *Journal of Food Engineering*, *63*(2), 177-184.
19. Hailu, D. (2017). Evaluation of Physicochemical Properties and Sensory Attributesof Biscuits Produced from Composite Flours of Wheat (Triticumaestivum l.) and Potato (Solanum tuberosum l). *Journal Science Quality Management*, 68: 1-5.