

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

Abstract

This study aimed to evaluate the effect of substituting whole wheat flour with acha and pigeon pea flours on the proximate composition, antinutrient content, physical characteristics, and sensory attributes of biscuits made from the blends. The blend of acha and pigeon pea was used to produce composite flour in the ratio of 100:0, 95:5, 90:10, 85:15, and 80:20. Biscuits made from this blend were analyzed for proximate composition, antinutrient content, physical attributes and sensory qualities. The results of 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 biscuit sample's protein, fat, moisture, and ash content increased while the fibre and carbohydrate content decreased with the addition of pigeon pea flour. The antinutrient content of the biscuit samples ranged from 41.24-64.23% for tannin and 3.85-4.68% for phytate. The biscuit samples showed a high concentration of anti-nutrients with the addition of more pigeon pea flour. The physical attributes of the biscuits ranged from 8.34-10.98kg, 0.56-0.85cm³, 4.21-7.21cm³, 4.77-5.03, 5.99-8.59 for weight, thickness, volume, diameter and spread ratio respectively. The sensory evaluation showed that the biscuit sample with the blend ratio of 95% and 5% (acha to pigeon pea flour ratio) was the most acceptable because it gave the best colour, appearance, crispness and overall acceptability. The result obtained 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, as well as reduce wheat importation, increasing the use of the most underutilized sources of flour in most developing countries.

Keywords: Anti-nutrient, composite flour, proximate composition, sensory evaluation and biscuit

1. INTRODUCTION

Biscuit is one of Nigeria's most commonly eaten non-fermented baked snacks [1]. Eggs, sugar, butter, and wheat flour are the essential raw materials widely used in the production process of biscuits. 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. Nevertheless, biscuits have a wide range of acceptance in terms of consumption by different 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 properties.

Biscuit as a snack food has the tendency to be used for protein fortification and substitute for diet improvements as a result of its general acceptance by various individuals regardless of their age bracket [2]. 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 [3, 4].

41 However, over-reliance and dependency on wheat flour for the production of different snacks in the pastry
42 industries in Nigeria has discouraged and prevented, to an extent, the use of other flour sources, such as
43 flour from cereals and tuber crops sources for domestic use.

44 Lately, the collaborative efforts of the Nigerian government with various research institutes across the nation
45 have improved the utilization of composite flour in producing different snacks such as biscuits and other
46 seemingly related food products such as bread. This recent development has encouraged the exploration of
47 other flour sources such as plantain, sweet potato, cassava flour, and other underutilized crops that can be
48 used as flour sources other than wheat flour. The use of this indigenous flour in the various baking industry
49 across the nation will multiply the usage of local crops cultivated in Nigeria, reduce over-dependency on
50 wheat flour and, most importantly, lower the cost of baked food products [5].

Comment [U1]: Can an approximate comparison between indigenous flour and wheat flour cost be shown?

51 Acha (*Digitaria exilis*) is a grain crop that has historically been consumed whole as *tuwo*, *couscous*, *gwate*,
52 *acha jollof*, and *kunun* acha [6]. Acha has high pentosane content (3.3%) and thus a high water absorption
53 capacity, making it suitable for use in bakeries [7]. It is roughly 73% carbohydrates and high in
54 micronutrients like iron and iodine (28.5 mg/100 ml and 22.9 mg/100 ml, respectively) [8]. Acha is used as a
55 health grain due to its gluten-free property and its consumption as a whole food product [9]. It is abundant in
56 methionine, therefore has low sugar concentration when consumed; this serves as an advantage to
57 diabetics patients [10, 11].

58 Pigeon pea is indigenously available, it has a low cost of production, and it is an under-utilized grain legume
59 both in the sub-tropics and tropics areas. Wide varieties of pigeon pea have protein content varying from 23-
60 26% [12]. Pigeon pea is rich in minerals and fiber, and its protein content is comparable with other
61 leguminous crops like cowpea and groundnut. Pigeon pea is well suited and adapted to Nigeria's climate for
62 cultivation, but its utilization in developing various food products has been limited majorly because its anti-
63 nutrient or phytochemicals make up the hard-to-cook phenomenon [13, 14]. Pigeon pea is desirable among
64 the low income earners in the urban area due to the taste, but it seems unaffordable due to the long cooking
65 time and high fuel cost. Aside from the hard-to-cook phenomenon, pigeon pea seeds are challenging to
66 dehull. Therefore, the seemingly tedious process of dehulling is a limiting factor in its utilization and
67 processing [15].

68 Most underdeveloped and developing countries like Nigeria depend heavily on wheat flour to make bread,
69 rolls, biscuits, and other pastry products. For this reason, the majority of these countries are conducting
70 research to see the possibility of replacing or substituting wheat for other flour sources needed for making
71 baked goods, wholly or partly with flour obtained from homegrown products. Flour from other sources that
72 can be used as a wheat substitute or composite flour includes legumes, tubers, fruits, cereals, etc. In our
73 modern world, constipation and diabetic patients are selective and careful with what they eat, especially
74 sugary foods. Composite flour made from pigeon pea and acha blends is used to make biscuits suitable for
75 everyone and contain more nutrients. However, in Nigeria, the use of acha and pigeon pea flour in the
76 production of baked goods is uncommon. There are scanty or no studies on using acha and pigeon pea flour
77 in biscuit production. This is because pigeon peas and acha flour are underutilized crops. Hence, this study
78 aims to evaluate the quality attributes of biscuits produced from acha and pigeon pea flour blends.

79 2. MATERIALS AND METHODS

80 2.1 Samples Procurement

81 Acha (*Digitaria exilis*) grains were purchased from Nyanya market, Abuja, and pigeon pea (*Cajanus cajan*)
82 was purchased at a local market in Bodija market in Ibadan, Oyo State. In addition, margarine, sugar, salt,
83 milk, egg and baking powder were procured from Wazo market in Ogbomoso, Oyo State, Nigeria.

84 2.2 Sample Preparation

85 [The method described by Adegoke [16] was used to obtain acha flour from acha seeds. Two kilograms of
86 acha were washed and dried. Hammer mill was then used to mill the dried acha, sieved and then the flour
87 was obtained through continuous sieving with a sieve aperture of 300 - 400 μm . About 2 kg of pigeon pea
88 was cleaned, sieved, washed and soaked in water to dehull and remove the shaft. The dehulled pigeon pea
89 was oven dried at 55 °C for 12 hours, milled into flour, sieved at 450 μm aperture and pigeon flour was
90 obtained at the end of this process.]

Comment [U2]: What was the yield of flour from
acha seeds?

91 2.3 Production of Biscuit

92 Five formulation mixes were prepared using acha flour (AF) ratios and pigeon pea flour (PPF). According to
93 Ihekoronye and Ngoddy [17], the method was adopted with slight modification. The formulations containing
94 sugar (60 g), baking powder (1%), milk (25 g), flavoring (2 g) and water (50 ml) have been used to produce
95 different cookie patterns. Different proportions of flour are weighed and mixed with the dry ingredients
96 (sugar, baking powder, water, cooking fat, vanilla, salt and milk. The dry ingredients are first weighed and

Comment [U3]: What was the yield of flour from
pigeon pea?

Comment [U4]: Which process is more cost
effective taking energy consumption and time into
consideration?

98 mixed before added butter and then whipped cream. Add water and mix well, until desired thickness is
99 achieved. The dough is then cut into a circle using a cookie cutter. The formed biscuits are baked at 180 °C
100 for 15 - 20 minutes, cooled and packed.

Comment [U5]: Was packaging material airtight?

101 2.4 Analyses

102 2.4.1 Proximate composition of biscuits

103 The proximate composition of the biscuit samples was determined according to the method described by
104 AOAC [18]. The fat content was determined by the soxlet extraction method in which hexane was used as
105 the solvent. The protein content was determined by the Kjeldahl method. The crude fiber was determined by
106 weighing approximately 0.5 g of the sample defatted in a tar-impregnated porcelain crucible. Then it is
107 burned at 600 °C for about six hours in the oven until the fiber is obtained. Ash content is also determined by
108 this method. Moisture content is determined by the hot air oven method. Carbohydrate content was
109 determined by sample difference, i.e.

$$110 \text{ \% carbohydrate content} = (100 - \text{\% crude fiber} + \text{\% protein} + \text{\% fat} + \text{\% ash} + \text{moisture content}) \quad (1)$$

111 2.4.2 Anti-Nutritional Factors of Biscuits

112 Folin-Denis spectrophotometric method was used to determine the tannin content [19]. The phytate content
113 of the samples was determined according to the method of AOAC [18].

114 115 2.4.3 Physical attributes of biscuits

116 An electronic scale was used to measure the weight of biscuits and the mean of biscuit samples was
117 recorded. The biscuit diameter was determined using [18]. Six biscuit samples are placed horizontally next
118 to each other, and the diameter of the biscuit was measured with a digital caliper. The mean of six biscuit
119 samples was obtained and used to indicate the diameter of the biscuit. The biscuit thickness was
120 determined using the method described by Man *et al.* [20]. In this method, six biscuits samples were
121 stacked, and the average thickness was obtained using a caliper. The average value obtained is used to
122 specify the thickness of the cookie. The biscuit spread ratio was defined as the mean diameter to mean
123 thickness [21].

124 2.5 Sensory Evaluation

125 The biscuits samples were presented to 50 panelists from Food Engineering Department, LAUTECH,
126 Ogbomoso for sensory evaluation in the sensory laboratory. Individual panelists were given at random six

127 (6) samples of biscuits neatly arranged on a rectangular shaped plastic tray. The biscuits were sealed
128 separately in a pouch and were coded before the commencement of the sensory evaluation process.
129 Panelists were required to evaluate sensory attributes such as colour, crispness, taste and the overall
130 acceptability of the biscuits with the aid of a 9-point hedonic scale according to Larmond [22].

131 2.6 Statistical Analysis

132 The data results obtained were analyzed using ANOVA, and Duncan's multiple range test was used to
133 detect significant differences ($p < 0.05$) between sample values using Statistical Package Version for the
134 Social Sciences (SPSS) 21.0.

135 3. RESULTS AND DISCUSSION

136 3.1 Proximate Composition

137 Proximate composition results for biscuits made from acha and pigeon peas flour are shown in Table 1. The
138 moisture content of biscuits ranged from 7.87 to 9.84%. The value of the results obtained in this study is
139 similar to the results reported by Ayo and Andrew [23] on biscuit made from acha-date palm flour. Biscuits
140 with less than 5% moisture content have a long shelf life as less than 5% moisture content is reported to be
141 damaged free and harmful bacteria.

Comment [U6]: Was microbiological quality testing of the biscuits conducted?

142 The protein content of biscuits ranged from 5.36 to 8.14%. The protein content of the biscuits increased with
143 the addition of pigeon pea flour. The increase may be due to the high protein content in pigeon peas [13,
144 14]. The high concentration of protein in the biscuits can also be attributed to the addition of a significant
145 amount of whole eggs in the formulation and also acha is considered as one of the nutritious of all grains; its
146 seeds contain 8.79% protein

Comment [U7]: A summarised chart containing nutritional content of acha seeds and pigeon pea flour might be helpful for better comprehension. Making note of change in raw seeds and pea, dehulled/processed and cooked product in different stages may show changes in nutrient content

147 The biscuit fat content ranged from 21.99 to 26.33%. The fat content was significantly different ($p < 0.05$). The
148 addition of pigeon pea flour increased the ash content of the cookie sample. The presence of ash in cookies
149 and any other baked food product indicates the presence of minerals in the food. The results obtained in this
150 study for ash content were similar to those obtained by Usman *et al.* [25] when carrot extract was added to
151 the flour and cornmeal mixture. Ash is an inorganic compound used as a mineral indicator in foods. It
152 contributes to the metabolic activities of other compounds such as proteins, lipids, and carbohydrates [24].
153 Carbohydrate content ranged from 58.06 to 63.01%. The results obtained for carbohydrates in this study
154 were similar to those reported by Ufot *et al.* [26]. However, there is a significant difference ($p < 0.05$) between

155 the samples. Carbohydrates are an excellent source of energy used in daily human activities. The
 156 carbohydrate content in these samples suggests that the products are a prominent energy source.

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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	21.99±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	22.83±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	22.88±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	24.68±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	26.33±0.18 ^c	1.24±0.13 ^d	0.39±0.17 ^a	58.06±1.00 ^a

159 Means with the same superscript within the same column are not significantly different (p>0.05). A= 100% Acha flour +
 160 0% pigeon pea flour; B= 95% Acha flour + 5% pigeon pea flour; C= 90% Acha flour + 10% pigeon pea flour; D= 85%
 161 Acha flour + 15% pigeon pea flour; E= 80% Acha flour + 200% pigeon pea flour
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163 3.2 Anti-Nutritional Composition of Biscuit

164 Table 2 shows the anti-nutritive composition of the biscuits. The antinutrient content of the sample ranged
 165 from 41.24 to 64.23 mg/100 g for tannin and 3.85 to 4.68 mg/100 g for phytate, respectively. There is a
 166 reduction in the antinutrient content of biscuits compared to raw beans. This is likely due to the heat applied
 167 when making the biscuits. Apata and Ologhobo [27] reported that some anti-nutrients are heat-labile and
 168 thus are significantly reduced when heat is applied. The phytate content of the pigeon pea flour used in
 169 biscuit production is hydrolyzed when stored at 55% relative humidity and 50 °C, contributing to the
 170 increased titratable acidity of the biscuit samples. The results of the phytate content obtained in this study
 171 were different in value compared to the result obtained and reported for some underutilized legumes and
 172 some cookies [28]. Tannins have been linked to lower feed intake, growth rate, feed efficiency, and protein
 173 digestibility in humans and animals. This study's findings were superior to those reported by Amadi [29]. The
 174 amount of tannin discovered in this study is considered in high concentrations and thus toxic. Prior to use,
 175 the tannin level in the pigeon pea should be reduced carefully through processing.

176

177 **Table 2. Anti-nutritional properties of biscuit from blends of acha and pigeon pea flour**

Sample	Tannin (mg/100g)	Phytate (mg/100g)
A	41.24±1.00 ^a	3.85±1.00 ^a
B	64.23±1.00 ^e	4.09±0.12 ^b
C	60.82±1.00 ^d	4.11±0.12 ^b
D	51.63±1.00 ^c	4.26±0.12 ^b
E	50.46±1.00 ^b	4.68±1.00 ^c

178 Means with the same superscript within the same column are not significantly different (p>0.05).

179 *Symbols A, B, C, D and E are as defined in Table 1

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181 3.3 Physical Attributes of Biscuit

182 The results of physical attributes are shown in Table 3. The physical attributes values varied
183 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
184 spread ratio, respectively. The increase observed in the physical attributes of the biscuit samples could
185 result from the higher fat and starch content of the pigeon pea flour. Ayo *et al.* [30] and Okaka and Isieh [31]
186 reported similar observation on biscuits produced from acha-wheat biscuit supplemented with soybean flour
187 and cowpea-wheat biscuits. The spread ratio decreased with the addition of pigeon pea flour. The pigeon
188 pea flour had a high and positive effect on the spread ratio. The inclusion of pigeon pea flour enhanced the
189 spreadability of the biscuit samples reduced with the level of replacement with acha flour.

190

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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

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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

194

195 3.4 Sensory Attributes

196 The results of the sensory evaluation of biscuits are shown in Table 4. The assessment of sensory attributes
197 of any food product plays a vital role in its development as it is used to assess the general acceptability of a
198 food product. Table 4 indicate that the average tasting ratings for taste, sweetness, crispiness, shape, colour
199 and flavour varied between samples. Taste and appearance are among the most commonly used sensory
200 parameters to assess the end consumer's overall acceptability of any finished food product. The mean
201 scores for the biscuit flavour ranged from 5.10 to 7.96, and they differed significantly ($p<0.05$). Biscuits had
202 mean scores ranging from 4.2 to 8.0, which differed significantly ($p<0.05$). The mean overall acceptance
203 scores ranged from 4.0 to 8.0, with significant differences ($p<0.05$). However, sample A (100% of wheat flour
204 and 0% pigeon pea flour) with the highest mean score was the best-accepted sample in terms of overall
205 acceptability while sample E (80% of flour and 20% pigeon pea flour) is the least preferred in terms of

206 general acceptability. The average overall acceptance score for samples A (100% of flour and 10% pigeon
 207 pea flour) and E (80% of flour and 20% of pigeon pea flour) was less preferred ($p < 0.05$).

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

210 Means with the same superscript within the same column are not significantly different ($p > 0.05$).

211 *Symbols A, B, C, D and E are as defined in Table 1

212 4. CONCLUSIONS

213
 214 The findings of this study indicated that composite flour from acha and pigeon pea could be used to make
 215 biscuits with improved nutritional attributes and characteristics. Biscuits produced from 95% of acha flour
 216 and 5% of pigeon pea flour were the most accepted by the panelists. Therefore, the production of biscuits
 217 from acha and pigeon pea flour blends should be encouraged as it will enhance the usage, increase the
 218 income of local farmers, and reduce or eliminate the problem associated with protein-energy malnutrition is
 219 prevalent in most communities and developing countries including Nigeria.

221 REFERENCES

- 222 1. Ogunjobi MK, Ogunwolu SO. Physicochemical and sensory properties of cassava flour biscuits
 223 supplemented with cashew apple powder. *Journal of Food Technology*. 2010;8:24-29.
- 224 2. Serrem C, Kock H, Taylor J. Nutritional quality sensory quality and consumer acceptability of
 225 sorghum and bread wheat biscuits fortified with defatted soy flour. *International Journal of Food
 226 Science and Technology*. 2011;46:74-83.
- 227 3. Olaoye OA, Onilude AA, Oladoye CO. Breadfruit flour in biscuit making. *African Journal of Food
 228 Science*. 2007;1(2):20-23.
- 229 4. Olapade AA, Awoh OC, Oluwole OB. Quality attributes of biscuits from acha flour supplemented
 230 with cowpea flour. *African Journal of Food Science and Technology*. 2011;2:198-203.
- 231 5. Ayo JA, Gafa T. The effect of un-defatted soybean flour on the protein content and sensory quality
 232 of *kunnu zaki*. *Nigerian Food Journal*. 2002;20:7-9.
- 233 6. Jideani IA. Acha (*Digitaria exilis*) the neglected cereal. *Agricultural International*. 1990;42:132-134.
- 234 7. Lasekan OO. Chemical composition and physical characteristics of acha (*Digitaria exilis*) flour.
 235 *Nigerian Food Journal*. 1994;12:19-23.
- 236 8. Oburuoga AC, Anyika JU. Nutrient and antinutrient composition of mungbean (*Vigna radiate*), acha
 237 (*Digitaria exilis*) and crayfish (*Astacus fluviatilis*) flours. *Pakistan Journal of Nutrition*.
 238 2012;11(9):743-746.
- 239 9. Jideani IA, Jideani VA. Developments on the cereal grains *Digitaria exilis* (acha) and *Digitaria iburua*
 240 (iburua). *Journal of Food Science Technology*. 2011;48(3):251-259.
- 241 10. NRC. Grains. Fonio (Acha), In: *Lost crops of Africa*, volume 1. National Academy Press, National
 242 Research Council Will be hington,DC, USA. 1996; pp 59–75, ISBN 0-309-04990-3.

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11. Ayo JA, Haruna US, Bitrus Y, Onajaiife F. The effect of dough improvers on the physical and sensory quality of acha (*Digitaria exilis*) flour bread. Nigerian Food Journal. 2008;25(1):77-89.
 12. Onimawo IA, Akpojovwo AE. Toasting (dry heat) and nutrient composition, functional properties and anti-nutritional factors of pigeon pea (*Cajanus cajan*) flour. Journal of Food Processing and Preservation. 2006;30:742-851
 13. Nene YL, Hall SD, Sheila VK. Pigeon pea. CAB International, Wallingford, University Press, Cambridge. 1990; p. 490.
 14. Ahmed M, El-Tabey, S. Hard-to-cook phenomenon in legumes. Food reviews International Journal. 1992;8:91-221.
 15. Fasoyiro SB, Ajibade SR, Omole AJ, Adeniyon ON, Farinde EO. Proximate, mineral and anti-nutritional factors of some under-utilized grain legumes in South-West Nigeria. Nutritional Food Science Journal. 2005;38:18-23.
 16. Adegoke GO. Understanding food microbiology. 2nd edition, alleluia ventures, Ibadan, Nigeria. 2004: ISBN: 978-36676-1-0, p. 216.
 17. Ihekoronye AI, Ngoddy PO. Integrated Food Science and Technology for the tropics. MacMillan Edu. Publishers, London. 1985; pp. 172-193.
 18. AOAC. Official Methods of Analysis, 17th ed. Association of Official Analytical chemist, Washington, D.C., U.S.A. 2005.
 19. Pearson D. The Chemical Analysis of foods. 8th ed. Churchill Livingstone, Edinburg. 1979.
 20. Man S, Paucean A, Muste S. Preparation and quality of gluten-free biscuit. Bull. UASVM Food Science and Technology. 2014;7(1):39-41.
 21. Akubor PI, Ukwuru MU. Functional properties and biscuit making potential of soybean and cassava flour blends. Plant Foods for Human Nutrition. 2004;58:1-12.
 22. Larmond E. Laboratory methods for sensory evaluation of food. Department of Agriculture, Ottawa, Canada. 1997; pp. 18-46.
 23. Ayo JA, Andrew E. Effect of added Bambara groundnut on the quality of acha-date palm based biscuit. International Journal of Biotechnology and Food Science. 2016;4(3):34-38.
 24. Okaka JC, Ene GL. Food microbiology method in food safety control. OCJANCO Academic publishers Enugu. 2005; pp. 262.
 25. Usman GO, Ameh UE, Alifa ON, Babatunde RM. Proximate composition of biscuits produced from wheat flour and maize bran composite flour fortified with carrot extract. Journal of Nutrition and Food Sciences. 2011;5:395-400.
 26. Ufot EI, Etimi AD, Florence AB. Production and quality evaluation of functional biscuits from whole wheat flour supplemented with acha and kidney bean flour. Asian Journal of Agriculture and Food Sciences. 2018;6(6):193-201.
 27. Apata DF, Ologhodo AD. Biochemical evaluation of some Nigerian Legume seeds. Food chemistry Journal. 1994;49:333-338.
 28. Oboh G. Nutrient enrichment of cassava peels using a mixed culture of *saacharomyces cerevisiae* and *lactobacillus spp* solid media fermentation techniques. Electronic Journal of Biotechnology. 2006;9(1):1-4.
 29. Amadi AC. Production, chemical and sensory evaluation of cookies fortified with *Moringa oleifera* leaves. Journal of Dieticians Association of Nigeria. 2017;8:96-103.
 30. Ayo JA, Ayo VA, Adewori R. Physiochemical in-vitro digestibility and organoleptic evaluation of acha- wheat biscuit supplemented with soybean flour. Nigerian Food Journal. 2007;25(1):77-89.
 31. Okaka JC, Isieh MI. Development and quality evaluation of cowpea-wheat biscuits. Nigerian Food Journal. 1990;8:56-60.

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