Quality Characteristics of Cookies Prepared from Wheat and Fermented Afzelia Africana Flour

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Abstract This study was carried out to evaluate the quality characteristics and acceptability of cookies produced from wheat flour and fermented Afzelia africana flour blends in various proportions (100:0 (sample A and control), 90:10 (sample B), 80:20 (sample C), 70:30 (sample D) and 60:40 (sample E). The proximate, physical, mineral, vitamin and sensory properties were determined. The result of the proximate composition showed that there was significant increase (P<0.05) in the protein (6.08 to 12.33%), fibre (1.88 to 5.89%), ash (1.35 to 3.02%), fat (19.29 to 27.06%) and energy (431.29 to 458.78kcal). The carbohydrate content decreased with the addition of fermented Afzelia africana flour and ranged from 41.48-58.34% while the value for the moisture content varies from 9.39 to 13.06% which decreased significantly (P<0.05) with increase in fermented africana flour. The physical properties were ; the diameter (12.25 to 13.50mm), thickness (12.25 to 13.50mm), Weight (19.75 to 18.20g) and spread ratio (3.30 to 3.83) of the cookies. The minerals and vitamins increased significantly at (P<0.05) with the addition of Afzelia africana flour. The result ranged as follows; iron (1.67 to 3.00mg/100g), calcium (15.21 to 116.03mg/100g), zinc (0.55 to 2.98mg/100g), potassium (55.86 to 388.68mg/100g), beta-carotene (1.54 to 2.08mg/100g), vitamin C (0.01 to 0.92mg/100g). The sensory scores showed that cookies produced from 100% wheat flour (sample A and control) compared favourably with the cookies from 90% wheat flour and 10% fermented Afzelia africana flour (sample B), 80% wheat flour and 20% fermented Afzelia africana(sample C), 70% wheat flour and 30% fermented Afzelia africana(sample D), 60% wheat flour and 40% fermented Afzelia africana(sample E) . All the cookies were generally acceptable and scored above 5 on the 9-point Hedonic scale. Therefore wheat flour can be substituted up to 40% fermented Afzelia Africana flour in baking depending on the nutritional needs. This would enhance the utilization of this underutilized crop and help to increase protein, energy and decrease malnutrition problem in developing countries.

Keywords: wheat flour, fermented Afzelia Africana flour, cookies

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1. Introduction

Cookies are a form of confectionary products usually dried to a low moisture content [1]. Compared to biscuit they tend to be larger with softer, chewer in texture and consumed extensively all over the world as a snack food and on large scale in developing countries where protein and caloric malnutrition are prevalent [1]. Cookies are considered to be a concentrated food due to high contents of carbohydrate, fat, low moisture and as a substantial source of energy. From a nutritional point of view its quality can be enhanced by including a number of ingredients in the recipe. In this way cookies have a great potential to become a good medium for providing special dietary needs. Another important aspect in designing cookies with improved nutritional status is the maintenance of a product's sensory characteristic because the consumer acceptability remains the key factor which determines the successful application of a newly developed product [2].

Wheat (*titricum spp*) is one of the most important staple foods for humans [3]. The kernel consists of the wheat germ and endosperm, which is full of starch and protein [4]. The consumption of wheat flour is on the increase due to the increase demand for cookies, noodles, bread, biscuits etc. The fortification of wheat flour with high protein materials from plant sources to increase the protein and improve the essential amino acid most especially lysine which is deficient in most grain cereal to balance resultant baked product such as cookies has been recognized [5].

Mahogany bean (*Afzelia africana*) also known as African mahogany or African oak is a large deciduous tree. It is a leguminous tree which belongs to the family of *Fabaceae,* sub-family *Caesalpiniaceae* and found in humid and dry forests. The genus name *Afzelia* was named

in honour of Adam Afzelius, a Swedish botanist who made the first collection during his visit to Sierra Leone in the eighteenth century [6]. *Afzelia africana* is a legume rich in complex carbohydrate, protein and dietary fibre which will supplement wheat to increase the protein, mineral content to meet WHO recommendation [7]. Legumes are rich in complex carbohydrate both starch and dietary fibre, which have potential to lower blood sugar level, blood pressure and cholesterol level. It also reduces the consumption of high carbohydrate diet especially for patients with diabetes [8]. The use of *Afzelia africana* seeds in production of cookies would increase its utilization and availability all year round. Considering the nutritional and promotion of the utilization of *Afzelia africana* seed, this study aimed at evaluating the quality characteristics of cookies prepared from wheat by incorporating fermented *Afzelia africana* flour into it to determine their physicochemical, sensory properties.

2. Materials and Methods

2.1. Sources of Raw Materials

Wheat flour and ingredients such as sugar, fat, flavour among others were purchased from North bank market, Makurdi, Benue state, Nigeria. Afzelia africana seeds were purchased from railway market, Makurdi. Equipment such as bowl, knife, weighing scale, measuring cylinder, baking pans, and oven were obtained from the food processing laboratory of Federal University of Agriculture, Makurdi.

2.2. Samples Preparation

2.2.1. Preparation of Fermented *Afzelia africana* Flour

The method of Igbabul *et al.* [9] was used in the preparation of fermented *Afzelia africana* flour as shown in Figure 1. Seeds of Afzelia Africana were sorted, de-capped, winnowed and cleaned to do away with dust, foreign matters, stones and defective seeds. The seeds were roasted for about 3-5 minutes to facilitate de-hulling. The de-hulled seeds were fermented naturally at 72 hours; oven dried at about 60°C for 48 hours, milled into flour in the attrition mill and sieved using a 1.0mm sieve.

2.2.2. Preparation of Cookies

The cookies were baked using the method described by [23]. The ratio of ingredients used for the preparation of cookies is shown in Table 4, while the flow chart for cookies production is shown in Figure 2. Fat and sugar were creamed to a smooth consistency. Eggs were added and mixed. Flour, baking powder and salt were mixed together and added to form dough. The dough was kneaded into uniform thickness and cut into different shapes and then placed in greased pans and egg washed.

The cookies were baked at about 150°C-185°C for 20 minutes.

2.2.3. Formulation of Blends

Wheat flour and *Afzelia africana* flour were mixed at different proportions. Sample A was the control with 100% wheat flour while samples B-E had wheat and *Afzelia africana* flour in the ratio 90:10,80:20,70:30 and 60:40 respectively as shown in Table 1.

Table 1. Blends formulation

Samples	Wheat Flour (%)	*Afzelia africana* Flour (%)
A	100	0
B	90	10
C	80	20
D	70	30
E	60	40

3. Analyses

3.1. Determination of Proximate Composition of Cookies

Moisture, ash, protein, fat and crude fibre were determined using the method of AOAC [10]. Carbohydrate was also determined by difference as described by Ihekoronye and Ngoddy [11]. The method described by Egounlety [12] was used in determining the caloric value by computation.

3.2. Determination of Physical Properties of Cookies Prepared from Wheat and Fermented Afzelia Africana Flour Blends

Diameter; Five (5) cookies were placed edge by edge. The total diameter was measured using a meter rule and the reading reported in mm. The cookies were then rotated at 90°C for duplicate readings and a mean was taken.

Thickness; Five (5) cookies were placed on top of each one, the total height was measured using a meter rule and expressed in mm. The process was then repeated to obtain duplicate readings and an average value was taken.

Weight; the cookies weights were determined using a digital weighting balance.

Spread factor; the spread factor were determined from the measured diameter (D) and thickness using the formula;

$$SF = \frac{D}{T} \times CF \times 10$$

Where: CF is the correction factor at constant atmospheric pressure and given as 1.

3.3. Determination of Mineral Composition of Cookies Prepared from Wheat and Fermented Afzelia Africana Flour Blends

Mineral elements (iron, calcium, potassium and zinc contents) were determined using atomic absorption spectrophotometer (AA800 Perkin Elmer, Germany) as described by AOAC [10]. Vitamin content determination was done using AOAC, [10] procedure.

3.4. Sensory Evaluation of Cookies

Twenty four (24) hours after preparation of the cookies, sensory evaluation was carried out. Cookies were

presented to fifteen (15) semi-trained panelists who were selected from the Department of Food Science and Technology Federal University of Agriculture Makurdi. Panelists were instructed to evaluate the appearance, taste, texture, crispness, aroma and general acceptability of the cookies. A 9-point Hedonic scale was used with 1-dislke extremely, 5 = neither like nor dislike, and 9 = like extremely (Ihekoronye and Ngoddy 1985). During the evaluation, panelists were given water to rinse their mouth after each evaluation for effective evaluation and asked to comment freely on the five samples on the questionnaires given to them.

3.5. Statistical Analysis

The data obtained from the sensory evaluation were subjected to Analysis of Variance as described by Iwe [13] where the Least Significant Difference was used to ascertain the difference between samples at P<0.05.

4. Results and Discussion

4.1. Proximate Composition of Cookies Prepared from Wheat and Fermented Afzelia Africana Flour Blends

Addition of fermented Afzelia africana flour resulted in some significant changes at (P<0.05). The moisture content ranged from 9.39% to 13.06%. The highest value (13.06%) was observed in sample A (100% wheat flour) while the lowest value (9.39%) was observed in sample D(50% wheat flour and 30% Afzelia africana flour), although it was reported by [13] that legumes flours has high water binding properties due to their high moisture content. Low moisture content in cookies would reduce the activities of microorganism and thereby increase the storage periods of the cookies compared with the control sample A (100% wheat flour) [14,15,16].

The protein content of the cookies which ranged from 6.08% to 12.33%, sample E, which is 60% wheat flour and 40% fermented Afzelia africana flour had the highest protein content of 12.33%. According to Igbabul *et al.* [9] fermented Afzelia africana flour has been reported to contain about 26.80%. Therefore the increase of protein in the substitution of Afzelia africana flour with wheat was due to naturally high protein content of Afzelia africana flour. The high protein content of the flour is an indication that it's could help to reduce malnutrition problem like kwashiorkor and also, especially for individuals with health problems that may require protein rich foods [17].

Ash content of cookies ranged from (1.35% to 3.02%) for the sample A and Sample E respectively. The addition of Afzelia africana flour significantly (P<0.05) increased the ash content of the cookie progressively. The result is similar to that reported by Gernah *et al.* [18] who observed an increase in ash content (1.85% to 2.89%) incookies produced form wheat brewers spent grain flour

blends. Ash content of a food material is indication of the mineral constituents present. The increase in the ash content could make the product a good source of minerals as observed by [19]. The fibre content of the cookies which ranged from (1.85-5.98%) increased with increase in the substitution level of Afzelia africana flour. It has been reported that high fiber intake prevent diet related disease like cardiovascular disease, cancer of the colon and diabetes [20,21,22].

The carbohydrate content decreased significantly (P<0.05) with increase in fermented Afzelia africana flour. The value ranged from 58.34% to 41.48% due to the increase in protein content of the Afzelia africana flour. The decreased carbohydrate content of the cookies with the addition of fermented Afzelia africana flour would be useful to people that need low carbohydrate foods leading to enhanced health for overweight and obsessed person. The same trend was observed by Igbabul *et al.* [23] with cookies made from cocoyam and African yam beans flour blends. The significant increase in fat content could have contributed to the high energy value ranged from 431.29kcal/100g to 458.78kcal/100g these values are however less than the values of 503.48, 505.64 and 509.11 kcal/100g reported by Noor *et al.* [24] for cookies made from mung beans and chickpea respectively.

4.2. Physical Properties of Cookies Prepared from Wheat and Fermented Afzelia Africana Flours Blends

The result of physical properties of cookies produced from wheat and fermented Afzelia africana flour blends is presented in Table 3. The weight of the cookies ranged from 18.20 to 19.25g which decreases with the addition of fermented Afzelia africana flour. The weight could be explained on the basis of low bulk density of fermented Afzelia africana flour stated by Igbabul *et al.* [9]. The diameter followed a similar trend as the thickness of cookies which are not significantly different (P>0.05) from the 100% wheat flour. The diameter increased significantly from 44.50 to 46.00mm with the control sample A made from 100% wheat flour recording the highest value and decreasing with addition of 10%, 20%,30%,40% Afzelia africana flour accordingly. This could be explained on the basis of increase in hydrophilic starch granules in Afzelia africana flour leading to moisture absorption and increase in diameter of cookies [23]. The increase in spread ratio could be attributed to the increased number of hydrophilic site in the dough mixture leading to increased water absorption and swelling index. The spread ratio varied from 3.30 to 3.83 and increased with the addition of Afzelia africana flour but not significantly different (P>0.05) from cookies with 100% wheat flour. Various researchers in contrast have reported increased spread ratio with usage of composite for cookies production [24,25,26]. Cookies having higher spread ratio are considered the most desirable [27].

Table 2. Proximate Composition of Cookies Prepared from Wheat and Fermented Afzelia Africana flour blends

Samples	Moisture (%)	Protein (%)	Fibre (%)	Ash (%)	Fat (%)	CHO (%)	Energy value(kcal)
A	13.06 [a]±0.04	6.08 [e]±0.01	1.88 [e]±0.01	1.35 [e]±0.01	19.29 [e]±0.01	58.34 [a]±0.07	431.29 [c]±0.21
B	12.10 [b]±0.01	8.15 [d]±0.06	3.13 [d]±0.04	1.68 [d]±0.01	21.35 [d]±0.05	53.59 [b]±0.00	439.11 [b]±0.70
C	11.21 [c]±0.03	9.82 [c]±0.01	5.20 [c]±0.01	2.06 [c]±0.00	22.67 [c]±0.04	49.04 [c]±0.01	439.47 [b]±0.38
D	9.39 [e]±0.03	10.20 [b]±0.05	5.37 [b]±0.01	2.32 [b]±0.01	25.22 [b]±0.01	47.50 [d]±0.01	457.78 [a]±0.25
E	10.13 [d]±0.01	12.33 [a]±0.01	5.98 [a]±0.01	3.02 [a]±0.00	27.06 [a]±0.04	41.48 [e]±0.07	458.78 [a]±0.22
LSD	0.08	0.08	0.01	0.11	0.08	0.11	1.03

• Values are mean ± Standard deviation of duplicate determinations. Means within the same column with different subscript are significantly different at P<0.05.

KEY:
Sample A = 100% Wheat flour (Control)
Sample B = 90% Wheat flour, 10% *Afzelia Africana* flour
Sample C = 80% Wheat flour, 20% *Afzelia Africana* flour
Sample D = 70% Wheat flour, 30% *Afzelia Africana* flour
Sample E = 60% Wheat flour, 40% *Afzelia Africana* flour
LSD = Least Significant Difference.

Table 3. Physical Properties of Cookies Produced from Wheat Flour and Fermented Afzelia Africana Flour

Samples	Diameter	Thickness	Weight	Spread ratio
A	44.50 [a]±0.71	13.50 [a]±0.71	19.75 [a]±0.21	3.30 [a]±0.12
B	44.50 [a]±0.71	12.50 [a]±0.71	19.05 [ab]±0.78	3.57 [a]±0.26
C	45.50 [a]±0.71	13.00 [a]±1.41	18.80 [ab]±0.14	3.52 [a]±0.44
D	46.00 [a]±1.41	13.50 [a]±0.071	18.85 [ab]±0.71	3.41 [a]±0.07
E	46.00 [a]±0.00	12.50 [a]±0.71	18.20 [b]±0.28	3.83 [a]±0.00
LSD	2.15	2.30	1.00	0.61

• Values are mean ± Standard deviation of duplicate determinations. Means within the same column with different subscript are significantly different at P<0.05.

KEY:
Sample A = 100% Wheat flour (Control)
Sample B = 90% Wheat flour, 10% *Afzelia Africana* flour
Sample C = 80% Wheat flour, 20% *Afzelia Africana* flour
Sample D = 70% Wheat flour, 30% *Afzelia Africana* flour
Sample E = 60% Wheat flour, 40% *Afzelia Africana* flour
LSD = Least Significant Difference

4.3. Mineral and Vitamin Composition of Cookies Prepared from Wheat Flour and Fermented Afzelia Africana Flour Blends.

The Mineral content of cookies prepared from wheat flour and fermented Afzelia africana flour blends is presented in the Table 4. Mineral such as iron, calcium, Zinc, potassium, carotene and vitamin C ranged from 1.67-3.00mg/100g, 15.21-116.03mg/100g, 0.55-2.98mg/100g, 55.86-388.68mg/100g, 1.54-2.08mg/100g and 0.01-0.92mg/100g respectively. The calcium iron, zinc, potassium, beta carotene and vitamin C content of composite cookies were significantly different (P<0.08) from 100% wheat cookies. According to [9] reported that Afzelia africana contain high amount of mineral and vitamin. The Increase in mineral and vitamin of cookies was due to the addition of fermented Afzelia africana flour. Potassium is an essential nutrient and has an important role in the synthesis of amino acid and protein in man [28].

Table 4. Minerals and Vitamins of Cookies Prepared from Wheat and Fermented Afzelia africana Flour Blends

Samples	Iron (mg/100g)	Calcium (mg/100g)	Zinc (mg/100g)	Potassium (mg/100g)	Beta-carotene (mg/100g)	VitC (mg/100g)
A	1.67 [e]±0.01	15.21 [e]±0.03	0.55 [e]±0.05	55.86 [e]±0.18	1.54 [e]±0.01	0.01 [e]±0.00
B	1.94 [d]±0.01	33.23 [d]±0.00	2.09 [d]±0.02	193.27 [d]±1.48	1.63 [d]±0.00	0.43 [d]±0.01
C	2.09 [c]±0.04	55.57 [c]±0.02	2.19 [c]±0.01	252.83 [c]±0.21	1.71 [c]±0.02	0.75 [c]±0.03
D	2.63 [b]±0.01	80.76 [b]±0.04	2.29 [b]±0.01	313.67 [b]±0.01	1.93 [b]±0.01	0.87 [b]±0.01
E	3.00 [a]±0.01	116.03 [a]±0.00	2.98 [a]±0.00	388.68 [a]±0.01	2.08 [a]±0.01	0.92 [a]±0.00
LSD	0.01	0.08	0.75	1.74	0.01	0.01

Value are means ± standard deviation of duplicate.
Values with different superscript within the same column are significantly different at (P<0.05)

KEY:
Sample A = 100% Wheat flour (Control)
Sample B = 90% Wheat flour, 10% *Afzelia Africana* flour
Sample C = 80% Wheat flour, 20% *Afzelia Africana* flour
Sample D = 70% Wheat flour, 30% *Afzelia Africana* flour
Sample E = 60% Wheat flour, 40% *Afzelia Africana* flour
LSD = Least Significant Difference.

Table 5. Sensory Scores of Cookies Prepared from Wheat and *Afzelia Africana* Flour Blends

Samples	Appearance	Texture	Taste	Aroma	Crispness	Overall acceptability
A	7.93[a]	7.53[a]	7.93[a]	7.80[a]	7.40[a]	8.00[a]
B	7.00[b]	7.20[a]	7.07[a]	7.00[ab]	6.80[ab]	7.07[b]
C	6.40[bc]	6.20[b]	6.00[b]	6.07[bc]	6.40[b]	6.40[bc]
D	5.80[c]	6.00[bc]	5.80[b]	5.47[cd]	6.40[b]	5.80[cd]
E	4.87[d]	5.20[c]	5.27[b]	5.00[d]	6.27[b]	5.40[d]
LSD	0.77	0.87	1.00	0.94	0.92	0.93

Values are mean ± Standard deviation of duplicate determinations. Means within the same column with different subscript are significantly different at $P<0.05$.

KEY:
Sample A = 100% Wheat flour (Control)
Sample B = 90% Wheat flour, 10% *Afzelia Africana* flour
Sample C = 80% Wheat flour, 20% *Afzelia Africana* flour
Sample D = 70% Wheat flour, 30% *Afzelia Africana* flour
Sample E = 60% Wheat flour, 40% *Afzelia Africana* flour
LSD = Least Significant Difference.

4.4. Sensory Attributes of Cookies Prepared from Wheat and Fermented Afzelia Africana Flour Blends

The result of the sensory attributes is shown in Table 5. For taste, there was a significant difference at ($P<0.05$) in sample A, B, C, D and E. But no significant difference in sample A and B, sample C and D, sample D and E. The difference observed in taste was as a result of the level of substitution of wheat flour and Afzelia africana flour. The aroma and the appearance followed a similar trend which are significantly different at ($P<0.05$). The appearance and aroma of the cookies increased gradually becoming darker with increased quantity of the Afzelia africana flour. The texture and crispness of 100% wheat flour and 90% wheat flour and 10% Afzelia africana flour are rated by the panelist are 7.53 and 7.20, 7.40 and 6.80 respectively. This implies that the texture and crispness of the cookies which served as a control and sample B were liked moderately by the panelists. Cookies produced from sample A (control) was most generally accepted followed by sample B and C which has no significant ($P>0.05$) difference. There is no significant ($P>0.05$) difference between sample D and E and the have the least generally acceptability with sample E having the lowest value. The substitution level of 10% and 20% of Afzelia africana flour produced a very good result..

5. Conclusion

The result of the study has shown that acceptable cookies can be produced from composite flour of wheat and fermented Afzelia africana flour which increases the protein (6.08-12.33%), fibre (1.88-5.98%), ash (1.35-3.02%), fat (19.29-27.06%), energy value (431.29-458.78%) of the cookies as well as the mineral and vitamin content of cookies due to addition of Afzelia flour.

It was further revealed that 10% fermented Afzelia africana flour and 90% wheat, 20% fermented africana flour and 80% wheat flour blend produced the best result following the 100% wheat cookies in terms of appearance, crispness, aroma, texture and overall acceptability.

This study also showed that fermented africana flour could be used to substitute wheat flour which is low in protein content and also shown that composite flour can be produced from underutilized crops such as Afzelia africana seeds which are rich in most nutritional qualities. Cookies with high nutritional value (such as ash, fat, protein and fibre) can be produced from wheat and fermented Afzelia africana which has a nutritional influence, fit for consumption and also serve as functional food.

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