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Physicochemical and Sensory Properties of Cookies Produced from Brown Rice and Fermented Afzelia Africana Flour Blends

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Abstract
Cookies were produced from brown rice and fermented Afzelia Africana flour blends and their physicochemical and sensory properties were determined. Five flour formulation, designated as samples A,B,C,D and E were produced. Sample A was control (100% wheat), while sample B,C,D and E were brown rice and fermented Afzelia Africana flour in the ratios 95:5, 90:10, 85:15, and 80:20 percentage respectively. The result of the proximate composition showed that there was a significant increase at $p<0.05$ in protein, fat, fibre, ash and moisture content. The value ranged from 8.15%-16.92%, 9.20%-10.06%, 1.25%-4.13%, 21.42%-25.95%, 1.06%-3.07% respectively. The physical property revealed the diameter, thickness, spread ratio and weight, ranged as; 4.33cm-4.46cm, 2.50cm-2.00cm, 17.32-22.30 and 13.40g-10.40g, respectively. The mineral content of calcium, phosphorus, potassium, and manganese increased at $p<0.05$ in the range 13.67mg/100g-24.17mg/100g, 33.27mg/100g-61.85mg/100g, 56.47mg/100g-322.42mg/100g and 56.44mg/100g-67.19mg/100g respectively. The beta carotene and vitamin C contents increased at $p<0.05$ in the range 1.57mg/100g-2.04mg/100g and 0.01mg/100g-2.15mg/100g respectively. The sensory scores showed that cookies produced from the brown rice and fermented Afzelia Africana flours all compared favourably with cookies from 100% wheat flour and therefore acceptable nutrient dense cookies could be successfully prepared from the composite flour of brown rice and fermented Afzelia Africana flour.
Keywords: Brown rice, fermented Afzelia Africana, cookies, composite flour, wheat
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1. Introduction

Cookies are one of the confectionary food products consumed in Nigeria especially among children. It is a ready to eat, convenient and inexpensive food product, containing digestive and dietary principles of vital importance according to (Oyeyinka et al., 2014). They are popular snacks widely consumed all over the world by people of all ages (Okpala et al., 2013). Cookies hold an important position in snack food industry due to variety in taste, crispiness and digestibility. Cookies are made in variety of style using an array of ingredients including sugars, spices, chocolates, butter, peanut butter, nut or dried fruits according to (Vijayakumar et al., 2013)

Afzelia Africana also called Mahogany bean is an underutilized legume plant in the family of fabaceae sub family Caesalpiniaceae. It has been reported that the seeds contain about 27.04% proteins, 31.71% crude fat, 33.09% total carbohydrates and 5.28% moisture, Igbabul et al., (2014). It is known by different names in Nigeria. It is called "yiase"; among the Tivs,, "akparata" among the Ibos and "apa" "ukpo" "kawa" among the Yoruba's, Idomas and the Hausa people of Nigeria respectively (Igbabul et al., 2014)

Researchers have reported that Afzelia Africana is a good source of protein as well as a soluble dietary fibre (Odenigbo 2004). Soluble dietary fibre has beneficial effects on blood glucose and lipid levels in diabetes mellitus, it lowers blood pressure and serum cholesterol (Anderson et al, 1999). Afzelia Africana provides protection against colon cancer, obesity and cardiovascular diseases according to (Ubom, 2007).

Apata and Akubor, (1997) reported that Afzelia Africana (Mahogany bean) has relatively high quantities of phosphorus, zinc, iron and exceptionally high calcium. Legumes however, contain a variety of toxic constituents as well as anti-nutritional factors such oxalate, saponin, haemoglutin, trypsin, phytates, tannin, protease inhibitor and goitrogen. Hence the need for fermentation.Fermented Afzelia Africana seed flour has been reported to contain decreased anti-nutrients, improved nutritional value (Igbabul et al 2014).

Rice, a major commodity in world trade, provides 20 % of the world's dietary energy supply (FAO, 2006). Rice contains approximately 7.3% protein, 2.2% fat, 64.3% available carbohydrates, 0.8% fibre and 1.4% ash content (Zhou et al., 2002). Rice is reported to have hypoallergenic properties due to the absence of gliadin (Gujral et al., 2004).

Brown unpolished rice would be used due to its high nutrients content (Pankaj, 2008). Composite flour refers to the mixture of different concentrations of non-wheat flour from cereals, legumes, roots and tubers with wheat flour or can be a mixture of flours other than wheat flour (Okpala et al 2011). Again Ubbor and Akobundu (2009) also reported that composite flours are recently manufactured not only to improve the desired functional properties of end product but also to improve nutritional composition which result to better balance in essential amino acid,

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thus, higher protein quality. Composite flour has several advantages in developing countries including the reduction of wheat flour importation and promotion of high-yielding native plant species by (Hasmadi et al., 2014).

The adoption of these locally produced flours in the bakery industry will increase the utilization of indigenous crops cultivated in Nigeria and also lower the cost of bakery products (Ayo et al., 2002).

There are several composite cookies readily available and investigated (Eke-Ejiofor et al 2015), but there is little information on the use of brown rice and fermented Afzelia africana flour blends. Therefore, fermented Afzelia africana, and brown rice flour would be used in this study to produce cookies and analysis of its physicochemical and sensory properties would be carried out.

2. Materials and Methods

2.1 Source of Raw Materials

Afzelia africana seed was obtained from a local market in Makurdi and the brown rice was obtained from MIKAP Nigeria Limited, producer of MIVA rice. Other equipment and reagent of analytical grade was obtained from the Food processing laboratory of Federal University of Agriculture.

2.2 Preparation of Raw Materials

2.2.1 Preparation of Fermented Afzelia africana Flour

Afzelia africana (mahogany bean) seeds was purchased from a local market and brought to the Food Chemistry Laboratory. About 4 kg of the Afzelia africana seed was sorted out and de-Capped, winnowed and cleaned to dislodge dust, foreign matter, stones, broken and defective seeds according to Igbabul et al., (2014). The seeds were roasted for 3-5minutes to aid de-hulling. The de-hulled seeds were fermented naturally at 72 hours, oven dried and milled into flour using the attrition mill and sieved using a 1.0mm sieve.

2.2.2 Preparation of Brown Rice Flour

According to Yeh (2004) brown rice grains was bought from Mikap producer of Miva rice. Rice was soaked for 4-5hrs for at 30 %, then grinded in excess water and dried at 40OC overnight, grinded and sieved with 1.0mm size to obtain fine flour using BSZ Pin mill. Flour samples were packaged in polyethylene bags and stored at 4 °C before use.

2.3 Formulationof composite flours

The fermented Afzelia Africana and Brown Rice flours were sieved using 1.0mm mesh sieve to obtain uniform particle size and then mixed in the proportions shown in Table 1. The proportions were based on preliminary work. Mixing was achieved with the use of Kenwood mixer at speed 6 for 3 min to obtain uniform blending.

2.4 Preparation of Cookies

The cookies were baked using the method of (Ceserani et al., 2008). The ratio of ingredient used for the preparation of cookies is shown in Table 2. Fat and sugar were creamed to a smooth consistency, and eggs were added and mix. The dry ingredients; flour, baking powder and salt was mixed together and added to cream followed by vanilla flavour and nutmeg and mix to dough. The dough was kneaded to a uniform thickness and cut into different shapes. They were placed in green pans that were egg washed. The cookies were baked at 150OC for 20min. The cookies were stored in a plastic container with lid in a refrigerator at 4 OC prior to analysis.

2.5 Analyses

2.5.1 Determination of Proximate Composition of Cookies

The protein, fat, crude fibre, ash, moisture contents were determined using the method (AOAC, 2005), while the carbohydrate was determined by difference using the method of (Egounlety, 2001), by subtracting the total sum of the percentage of fat, moisture, ash, crude fibre, and protein content from hundred (100). The gross energy values were estimated by multiplying the values of crude protein, fat and carbohydrate by their respective physiological fuel value of 4, 9 and 4 respectively.

2.5.2 Determination of Physical Properties of Cookies

Cookies diameter (D) and thickness (T) were determined using vernier callipers, while cookies weight was determined using an electronic weighing balance (Mettler PE160 Balance, Switzerland). Spread ratio was expressed as diameter/thickness (D/T) (McWatters et al., 2003). The average values of 2 replicate determinations were reported.

2.5.3 Determination of minerals and vitamin content of the cookies. This was carried out using the AOAC (2005) with the aid of Atomic Absorption Spectrophotometer (AA 800 Perkin Elmer Germany).

2.5.4 Determination of Sensory Properties of Cookies

Twenty-four hours after preparation of the cookies, sensory evaluation was carried out. A total of 15 panellists who were familiar with the quality attributes of the cookies were recruited from staff and students of the Department of Food Science and Technology. Each panellist evaluated all the samples prepared for each treatment in one session. Criteria for selection of panellists was that panellists were regular consumers of cookies and not allergic to any cookies. Panellists were instructed to evaluate appearance, flavour, texture, crispness, and general acceptability of the cookies. A nine-point Hedonic scale was used with1=dislike extremely, 5=neither like nor dislike, and 9=like extremely (Ihekoronye & Ngoddy, 1985). Samples were identified with three-digit code numbers and presented to panellists. The panellists were instructed to rinse their mouths with water after every sample. They were also asked to comment freely on samples on the questionnaires given to them.

2.6 Statistical Analysis

The data obtained from the work and sensory evaluation was subjected statistically to analysis of variance (ANOVA) and means were separated using Tukey's test. (Steele & Torrie, 1980). The least significance difference was used in determining significant differences between the means and separation of the means where significant differences existed at P, 0.05, using SPSS package version 16.0.

3. Result and Discussion

3.1 Proximate Composition of Cookies Produced Brown Rice and Fermented Afzelia Africana Flour Blends

The result of this study showed that the proximate composition of cookies varied significantly as shown in Table 3. These variations were a function of the different composition of the samples. The moisture content of the samples which ranged from 9.20% to 10.06%, this may be due to the consistency of baking temperature and time, since it was the same baking condition that was used for all. The value obtained from the determination of protein value of the cookies of Brown rice and fermented Afzelia Africana ranges from 8.15% to 16.92% with the least being sample A (control) and showed significant difference at ($P<0.05$). This increase in protein value could be attributed to increase in microbial mass during fermentation causing extensive hydrolysis of the protein molecules to amino acids and other simple peptide (Igbabul et al., 2014). These protein content values are comparable with the values of 6.83-16.6% reported by (Chinma and Gernah, 2007) on cookies from composite flour of wheat, mango and soybeans. Also comparable with the value of 10.44%-14.73% reported by (Igbabul et al., 2015) on cookies from composite flour of wheat cocoyam and African yam beans. Increase in crude fat ranges from 21.42% to 25.95% and showed significant different in all samples. This increase in fat could be a result of extensive breakdown of large molecules of fat into simple fatty acids (Igbabul et al., 2014). These increase in fat is however higher than the range of value of 18.12-20% reported by Ebere et al., (2015) on wheat flour, cashew, and apple residue as source of fibre in cookies production. The value obtained from the determination of dietary fibre showed an increase with no significant different at ($P<0.05$) of sample A and B. The increase in dietary fibre in Brown rice and fermented Afzelia Africana flour in cookies production shows that it would provide dietary fibre that would offer protection against cardiovascular diseases, obesity and colon cancer and promote the effective functioning of the human digestive tract (Igbabul et al., 2014). This observation is lower than that reported by Ebere et al., (2015) but of health benefit since it falls within the range of high fibre cookies as reported by Lerrea et al., (2005) and Camire et al., (2007). The crude fibre is also in agreement with the recommendation of (FAO/WHO, 1994) that fibre content should not be more than 5g dietary fibre per 100g dry matter of all cookies and that would enhance gastro intestinal tract and cardiovascular health. Ash content ranging from 1.06% to 3.07% shows that cookies produced from Brown rice and fermented Afzelia Africana will be rich in nutrient due to low ash content which may be due to leaching of soluble minerals into the processing water during fermentation period (Igbabul et al., 2014). Low ash content had earlier been reported for snacks made from Afzelia Africana seed flour (Onyechi et al., 2013). The ash content value are comparable with the values of 1.6-2.6% reported by Ebere et al., (2015). The observation in moisture content is in agreement with the report of Smith (1972) who established that moisture content of cookies should not exceed 14%. Okaka (2009) also reported low moisture for cookies. Carbohydrate content ranges from 58.92 – 39.87 Brown rice and fermented Afzelia Africana while the enegy value ranges from 473.07kcal – 460.71kcal Brown rice and fermented Afzelia Africana.

Table 1: Formation of Composite Flour for Cookies Production

Samples	Wheat(%)	Brown Rice flour (%)	Fermented Afzelia africana flour (%)
A (CONTROL)	100	0	0
B		95	5
C		90	10
D		85	15
E		80	20

Table 2. Quantity of Ingredients for Cookies Production

Ingredients	Percentage (%w/w)	Amount (g)
Vegetable fat	22.7	50
Suger (granulated)	18.8	40
Nutmeg	0.2	0.3
Vanilla flavour (liquid)	0.1	5.0 ml
Egg (whole, fresh)	7	30ml
Salt	0.4	1
Baking powder	14.6	2

Source: (Ceserani et al, 2008).

Table 3: Proximate Composition of cookies from Brown Rice and Fermented Afzelia Africana Flour Blends

Sample	Composition (%)						
	Protein	Moisture	Ash	Fat	Crude Fibre	CHO	E.V (kcal)
A	8.15e ±0.04	9.20c ± 0.05	1.06d±0.03	21.42e±0.04	1.25d ± 0.04	58.92a ± 0.04	461.06d ±0.02
B	12.27d± 0.08	8.95d ± 0.02	1.26c±0.04	23.28d±0.01	1.29d ± 0.08	52.95b ± 0.03	470.40b±0.02
C	13.96c ±0.01	10.96a±0.04	1.36c±0.04	24.15c±0.03	2.38c ± 0.01	47.19c ± 0.02	461.95c±0.01
D	15.11b ±0.03	9.31c ± 0.01	2.32b±0.01	25.09b±0.00	3.40b ± 0.04	44.77d ± 0.25	473.07a±0.03
E	16.92a ±0.01	10.06b±0.04	3.07a±0.04	25.95a±0.05	4.13a ± 0.01	39.87e ± 0.01	460.71e±0.01
LSD	0.11	0.11	0.10	0.06	0.10	0.44	1.25

*Values are means of ± standard deviations of duplicate determination
*Means within the same column with different superscripts are significantly different (P<0.05)
A (Control) = 100% Wheat
B = 95% Brown rice flour, 5% Fermented Afzelia Africana
C = 90% Brown rice flour, 10% Fermented Afzelia Africana
D = 85% Brown rice flour, 15% Fermented Afzelia Africana
E = 80% Brown rice flour , 20% Fermented Afzelia Africana
E.V= Energy value
L.S.D = Least Significant Difference

Table 4: Physical Properties of Cookies Produced from Brown Rice and Fermented Afzelia Africana Flour Blends.

Sample	**Diameter (cm)**	**Thickness (cm)**	**Spread Ratio**	**Weight (g)**
A	4.33e ± 0.00	2.50a ± 0.01	17.32e ± 0.07	13.40a ± 0.01
B	4.93a ± 0.01	2.27b ± 0.01	21.72d ± 0.07	13.20b ± 0.01
C	4.67b ± 0.01	2.13c ± 0.20	21.92c ± 0.07	13.00c ± 0.57
D	4.60c ± 0.01	2.00d ± 0.01	23.00a ± 0.07	12.20d ± 0.01
E	4.46d± 0.01	2.00d ± 0.21	22.30b ± 0.07	10.40e ± 0.01
LSD	0.02	0.01	0.06	0.03

*Values are means of ± standard deviations of duplicate determination
*Means within the same column with different superscripts are significantly different (P<0.05)
A (Control) = 100% Wheat
B = 95% Brown rice flour, 5% Fermented Afzelia Africana
C = 90% Brown rice flour, 10% Fermented Afzelia Africana
D = 85% Brown rice flour, 15% Fermented Afzelia Africana
E = 80% Brown rice flour , 20% Fermented Afzelia Africana
L.S.D = Least Significant Difference

Table 5: Mineral Composition of Cookies Produced from Brown Rice and Fermented Afzelia Africana Flour

Sample	Composition (mg/100g)			
	Calcium	Phosphorus	Potassium	Manganese
A	13.67e ± 8.09	33.27d ± 0.01	56.47e ± 0.34	56.44d ± 0.77
B	19.23d ± 0.03	43.40c ± 0.07	125.90d ± 0.67	57.13d ± 0.04
C	21.22c ± 0.04	50.27b ± 0.01	201.01c ± 0.01	59.22c ± 0.07
D	23.15b ± 0.04	57.99a ± 2.70	298.40b ± 0.03	63.18b ± 0.10
E	24.17a ± 0.06	61.85a ± 0.74	322.42a ± 1.41	67.19a ± 0.03
LSD	0.12	3.28	2.15	1.03

*Values are means of ± standard deviations of duplicate determination
*Means within the same column with different superscripts are significantly different (P<0.05)
A (Control) = 100% Wheat
B = 95% Brown rice flour, 5% Fermented Afzelia Africana
C = 90% Brown rice flour, 10% Fermented Afzelia Africana
D = 85% Brown rice flour, 15% Fermented Afzelia Africana
E = 80% Brown rice flour , 20% Fermented Afzelia Africana
L.S.D = Least Significant Difference

Table 6: Vitamin Composition of Cookies Produced from Brown Rice and Fermented Afzelia Africana Flour Blends

Sample	Composition (mg/100g)	
	Beta-carotene	Vitamin C
A	1.57c ± 0.03	0.01e ± 0.01
B	1.64c ± 0.01	0.20d ± 0.00
C	1.78b ± 0.01	0.35c ± 0.01
D	1.97a ± 0.01	1.17b ± 0.01
E	2.04a ± 0.01	2.15a ± 0.02
LSD	0.05	0.04

*Values are means of ± standard deviations of duplicate determination
*Means within the same column with different superscripts are significantly different (P<0.05)
A (Control) = 100% Wheat
B = 95% Brown rice flour, 5% Fermented Afzelia Africana
C = 90% Brown rice flour, 10% Fermented Afzelia Africana
D = 85% Brown rice flour, 15% Fermented Afzelia Africana
E = 80% Brown rice flour , 20% Fermented Afzelia Africana
L.S.D = Least Significant Difference

Table 7: Sensory Scores of Cookies Produced from Brown Rice and Fermented Afzelia Africana Flour

Sample	Sensory Attributes					
	Appearance	Aroma	Crispness	Taste	Texture	General Acceptability
A	7.53a ±0.92	7.67a±0.72	6.73a±1.67	8.00a±1.20	7.40a± 0.99	8.00a ± 0.76
B	6.80ab± 0.78	6.40b± 1.45	7.07a± 1.28	7.27a± 1.44	6.87ab±1.13	7.87a ± 0.86
C	5.73b ± 1.39	5.40b ± 1.84	6.67a± 1.18	6.07b± 1.22	6.53ab±1.06	6.40b ± 1.30
D	6.53ab± 1.60	5.93b ± 1.39	6.47a± 1.16	6.60b± 1.50	6.60ab±1.12	6.80b ± 1.08
E	6.53ab± 1.85	6.40b ± 1.12	6.73a± 1.44	6.53b± 0.92	6.80ab±0.86	6.80b ± 1.06
LSD	0.78	0.90	0.94	0.81	0.61	0.58

*Values are means of ± standard deviations of duplicate determination
*Means within the same column with different superscripts are significantly different (P<0.05)
A (Control) = 100% Wheat
B = 95% Brown rice flour, 5% Fermented Afzelia Africana
C = 90% Brown rice flour, 10% Fermented Afzelia Africana
D = 85% Brown rice flour, 15% Fermented Afzelia Africana
E = 80% Brown rice flour , 20% Fermented Afzelia Africana
L.S.D = Least Significant Difference

3.2 Physical Properties of Cookies Produced From Brown Rice and Fermented Afzelia Africana Flour Blends

The result of physical properties of cookies produced from Brown rice and fermented Afzelia Africana flour blends is presented in Table 4; the diameter of cookies gradually decreases with addition of fermented Afzelia Africana flour. The lowest diameter was recorded in cookies from sample A (control). This could be explained on the basis of increase in hydrophilic starch granules of fermented Afzelia Africana flour leading to moisture absorption and increase diameter of cookies. The thickness of cookies from sample A (control) flour were significantly different (P<0.05) from the cookies made from composite flours of rice and fermented Afzelia Africana and decrease with addition of rice and fermented Afzelia Africana flour, while weight of cookies decreases with the lowest been 13.40 of sample A (control). Spread ratio of cookies increased with the lowest being sample A of 17.32 and highest of being sample E of 22.30. The physical characteristics of cookies diameter, thickness, spread ratio and weight showed that there were significant difference (P<0.05) in all the samples. This could be as a result of the ability of insoluble fibre to absorb water up to 15 times its own weight and swelling up in size, causing variation in the diameter, thickness and spread factor as reported by Ogunjobi et al., (2010), Ogunwolu et al., (2010) and Oyewole et al.,(1996). The diameter, spread ratio and weight value is lower than that of 18.01cm, 15.16-11.78, and 18.01-20.15 respectively, and higher than 0.45-0.55cm in thickness reported by Igbabul et al., (2015). The diameter, spread ratio, and weight value is higher than that of 3.00-3.02cm, 6.25-6.04, and 2.91g-3.31g respectively, reported by Ebere et al., (2015).

3.3 Mineral Composition of Cookies Produced From Brown Rice and Fermented Afzelia Africana Flour Blends

The mineral content of cookies prepared from Brown rice and fermented Afzelia Africana flour blend is presented in Table 5. Minerals such as calcium, phosphorus, potassium, Manganese ranges from 13.67mg/100g to 24.17mg/100g, 33.27mg/100g to 61.85mg/100g, 56.47mg/100g to 322.42mg/100g and 56.44mg/100g to 67.19mg/100g respectively. Calcium, phosphorus, potassium and Manganese content of cookies were significantly (P<0.05) higher than 100% wheat (control) cookies. The increase in addition of Brown rice and fermented Afzelia Africana flour increase the mineral content of cookies. Deficiency of certain minerals like calcium, phosphorus has been shown to aggravate carbohydrate intolerance (Franz et al., 2002). This reult agrees to Adebayo et al., (2013) about the high content of minerals such as of potassium, phosphorus, and calcium present in Afzelia Africana and Pankaj (2008) of manganese present in brown rice.

3.4 Vitamin Composition of Cookies Produced From Brown Rice and Fermented Afzelia Africana Flour Blends

The vitamin content of cookies prepared from Brown rice and fermented Afzelia Africana flour blend is presented in Table 6. Vitamin such as beta carotene (Vitamin A) ranges from 1.57mg/100g to 2.04mg/100g while that of vitamin C ranges from 0.01 to 2.15mg/100g. Beta carotene and vitamin C content of cookies were significantly at (P<0.05) higher than 100% wheat (control) cookies. The beta carotene and vitamin C content increased with increase in the substitution of fermented Afzelia Africana which is a good source of beta carotene and vitamin C as reported by Emmanuel et al., (2011). The result of high vitamin A agrees with Onyechi et al., (2013) who reported high vitamin A content of snack made from Africana africana seed and vitamin C present in Afzelia Africana as reported by Egwuje et al., (2015).

3.5 Sensory Scores of Cookies Produced From Brown Rice and Fermented Afzelia Africana Flour Blends

The result in sensory attribute is shown in Table 7: for appearance, there was a significant difference at (P< 0.05) in sample A, B and C but no significant different in sample D and E. The difference observed in appearance was as a result of the roasting of fermented Afzelia Africana during preparation which increases its crude protein and minerals such as potassium, calcium, manganese, and phosphorus (Adebayo 2013). There was significant difference in the aroma of sample A (control) due to different flours used in preparing cookies. There was no significant different in the crispness of the cookies. This implies that the crispness of cookies that served as control (Sample A) and other samples (B, C, D and E) had no difference in consumer preference. Taste of sample A and B had no significant difference. This also implies that the taste of cookies which served as control (Sample A) and other samples (B, C, D and E) also had no difference in consumer preference but was significantly different in sample C, D and E. Texture of sample A as rated by the panelist is 7.40 and that of sample B, C, D and E to be 6.87, 6.53, 6.60 and 6.80 respectively. This implies that the texture of the cookies which served as control (Sample A) and other sample (B, C, D, E) were liked moderately.

4. Conclusion

Cookies with increased protein, fibre, ash, vitamins and minerals contents were produced successfully using composite flour of brown rice and fermented Afzelia africana flour blends.

The cookies made with the flour blends of brown rice and fermented Afzelia Africana compared favourably with the cookies produced from 100% wheat flour. Therefore its use for the production of cookies and other confectionaries will go a long way in alleviating malnutrition, hunger and also reduce dependence on wheat flour and its importation. This will lead to savings in foreign exchange and enhance farmers income.

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