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Nutrient composition and sensory properties of wheat-African bread fruit composite flour cookies

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The nutrient composition and sensory properties of wheat-African bread fruit composite cookies were investigated. The wheat flour (WF) was blended with African bread fruit flour (ABFF) in the ratios of 90:10, 80:20, 70:30, 60:40 and 50:50 and used for the production of cookies. The cookies produced were evaluated for proximate composition, vitamin content and sensory qualities using standard analytical methods. The proximate composition of the cookies showed that the protein, fat, ash and crude fibre contents of the samples increased significantly ($p \leq 0.05$) with increasing level of African bread fruit flour while carbohydrate decreased. The vitamin content of the samples revealed that the ascorbic acid, niacin, thiamin, riboflavin, folic acid and vitamin A contents of the cookies ranged from 2.22±0.00-4.13±0.04mg/100g, 2.47±0.01-3.72±0.05mg/100g, 28.77±0.78-42.22±0.85mg/100g, 9.64±0.04-12.68±0.06mg/100g, 7.30±0.08-10.20±0.11mg/100g and 0.92±0.00-2.11±0.01mg/100g, respectively. The control (wheat flour cookies) and the cookie samples with 50% African bread fruit flour substitution had the least and highest values. The sensory properties of the cookies also showed that the level of likeness of the sensory attributes: colour, flavour, texture, taste and overall acceptability reduced with increasing substitution of African bread fruit flour. The nutrient composition and sensory qualities of wheat-African breadfruit composite cookies observed revealed that African bread fruit flour could be used as a partial replacement for wheat flour at the levels of 10 to 50% in the production of cookies.

Key words: African bread fruit flour, cookies, proximate composition, vitamin content, sensory properties.

INTRODUCTION

In developing countries, legumes which are generally low in sulphur containing amino acids are used as natural complements for low lysine cereals in human and animal diets. The product formulated from such mixture is known to have an amino acid profile that is nearly complete in essential amino acid content (Okaka et al., 2006). The complementary role of legume protein and the increased cost of animal protein for human food has made legumes important as alternative sources of dietary protein. However, the use of legumes as protein source is limited by the presence of anti-nutritional factors which are a diverse range of naturally occurring compounds in many tropical plants. The presence of these anti-nutritional factors cause poor protein digestibility in man and animals and are capable of precipitating other deleterious effects. The manifestation of toxicity from the consumption of legumes that contain anti-nutritional factors range from severe reduction in food intake and nutrient availability or utilization to profound neurological effects and even death (El-Adawy, 2002; Ugwu and Orange, 2006; Osman, 2007). To improve the nutritional quality and organoleptic acceptability of leguminous seeds, processing techniques have been employed to reduced or destroy the anti-nutrients present in them. Some of the commonly used processing techniques include soaking in water, boiling at high temperatures in

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water, alkaline or acidic solutions, germination, roasting, dehulling, microwave treatment, autoclaving, steam blanching and fermentation (Udensi et al., 2005; Uzoechina, 2007, Okoye and Mazi, 2012).

African bread fruit (*Treculia africana*) is an important food crop in Nigeria. The extracted seeds have been found to be highly nutritious when adequately processed (Oyetayo and Omenwa, 2006). African bread fruits are rich in protein, carbohydrate, fat, vitamins and minerals. Like other Legumes, African bread fruits are rich in B-group vitamins such as thiamin, ascorbic acid, niacin, riboflavin and pyridoxine. It is also a rich source of Omega-3 and Omega-6 fatty acids which are very essential in the development of the mind and the body. The amino acid profile of African bread fruit is characterized by low concentration of sulphur amino acids such as methionine, tryptophan and cysteine but has high content of lysine, arginine and histidine (Okorie, 2013).

The seeds of African bread fruit can be processed into flour which can be also used as soup thickener or in the preparation of pastries, cookies and other confectionery products. The seeds can be also pressed to produce edible oil which is commonly used for cooking, frying and in the preparation of soaps (Nwabueze and Nwokenna, 2000). African bread fruit flour has a good potential for use as a functional ingredient agent in bakery and confectionery products because of its high water absorption capacity, solubility, bulk density, foam capacity and rapid viscosity characteristics (Okonkwo and Ubani, 2012). This shows that the flour is rich in protein and fat and can improve the pasting characteristics and also serve as a protein supplement.

Cookies which are known as soft type biscuits are widely consumed in many developed and developing countries of the world (Okpala et al., 2013). African bread fruit flour can be used in composite with other flours for the preparation of baked products (Giami et al., 2004). Composite flour is a mixture of different flours from cereals, nuts, legumes, root and tuber crops that is created to satisfy specific functional characteristics and nutrient composition. It refers to the process of mixing wheat flour with cereal and legume flours for production of baked food products like breads, biscuits, pie crust, doughnuts, sausages and cakes.

However, the replacement of wheat flour with 20 percent non-wheat flour for the manufacture of bakery products would result in an estimated savings in foreign exchange of twenty million US dollars for developing and underdeveloped countries of the world (FAO, 1990).

African bread fruits are widely grown and distributed in southern part of Nigeria. (Obum and Ajanwale, 2006). The utilization of non-conventional flours such as African bread fruit flour in the production of baked products can serve as an alternative means of extending the use of non- wheat flour because it has the potential to increase farmer’s income by adding value to the products, increase the protein intake of their consumers, support food diversification and security and reduce wheat importation. The objective of this study, therefore, is to determine the proximate composition, vitamin content and sensory properties of wheat- African bread fruit composite flour cookies.

MATERIALS AND METHODS

Fresh African bread fruit (*T. africana)* seeds used for the study were purchased from Aria Market Enugu, Enugu State, Nigeria. Commercial wheat flour and the other ingredients (sugar, fat, salt, baking powder, eggs and flavouring) used for cookie production were also purchased from the same market.

Preparation of germinated African breadfruit flour

The germinated African breadfruit flour was prepared according to the method of Ugwu and Oranye (2006). During preparation, one kilogramme (1kg) of African breadfruit seeds which were free from dirt and other foreign particles such as stones, leaves and sticks were soaked in 3 litres of potable at room temperature (30±2°C) for 24 h with occasional change of soak water at intervals of 6 h to prevent microbial fermentation. The soaked seeds were drained, rinsed and spread on wet jute bag and allowed to sprout at ambient temperature for 120 h. During this period, the seeds were sprinkled with water at intervals of 6 h to facilitate germination. The growth of the germinated seeds was terminated by drying the seeds in a hot air oven (Model DHG 9101 ISA) at 60°C for 10 h with occasional stirring of the seeds at intervals of 30 min to ensure uniform drying. The dried seeds were cleaned manually and rubbed in between palms to remove the sprouts and the hulls. The dehulled seeds were milled in a locally fabricated attrition mill and sieved through a 400 micron mesh sieve. The flour produced was packaged in an airtight plastic container, labeled and stored in a freezer until needed for further use.

Flour blend formulation

Wheat flour (WF) was blended with African bread fruit flour (ABFF) in the ratios of 90:10, 80:20,70:30, 60:40 and 50:50 in a Kenwood mixer (Model NX 908 G, Kenwood, Britain, UK) to produce wheat-African breadfruit composite flours. The composite flours produced were packaged individually in an airtight plastic container, labeled and stored at room temperature (30±2°C) until needed for cookie production.

Table 1. Proximate composition (%) of wheat-African bread fruit composite cookies.

Samples	Moisture	Crude Protein	Fat	Ash	Crude Fibre	Carbohydrate
A	10.43^{a}±0.41	13.85^{a}±0.04	6.76^{a}±0.03	3.39^{g}±0.01	4.19^{b}±0.01	65.57^{g}±0.06
B	8.60^{e}±0.04	9.84^{g}±0.02	3.86^{f}±0.03	4.82^{f}±0.02	3.83^{f}±0.03	72.84^{a}±0.06
C	8.64^{e}±0.04	10.55^{f}±0.05	4.32^{g}±0.08	4.89^{e}±0.05	3.95^{e}±0.04	71.58^{b}±0.05
D	9.21^{d}±0.02	11.30^{e}±0.04	4.42^{e}±0.02	4.95^{d}±0.06	4.03^{d}±0.04	70.16^{c}±0.05
E	9.29^{c}±0.02	11.84^{d}±0.04	4.48^{d}±0.01	5.02^{c}±0.03	4.15^{c}±0.01	69.38^{d}±0.09
F	9.36^{b}±0.04	12.28^{c}±0.06	4.53^{c}±0.05	5.16^{b}±0.04	4.18^{b}±0.02	68.74^{e}±0.07
G	9.44^{a}±0.04	13.08^{b}±0.10	5.66^{b}±0.07	5.24^{a}±0.06	4.24^{a}±0.03	67.76^{f}±0.11

Values are mean ± standard deviation of triplicate determinations. Means in the same column with different subscripts are significantly different ($p \leq 0.05$).
A – African bread fruit flour, B – Cookies made with 100% wheat flour, C – Cookies made with 90% wheat flour and 10% African bread fruit flour, D – Cookies made with 80% wheat flour and 20% African bread fruit flour, E – Cookies made with 70% wheat flour and 30% African bread fruit flour, F – Cookies made with 60% wheat flour and 40% African bread fruit flour, G – Cookies with 50% wheat flour and 50% African bread fruit flour.

Preparation of cookies

The cookies were prepared according to the method of Okpala et al. (2013). The recipe used for the preparation of cookies contained 100% flour, 40% sugar, 80% fat, 2% baking powder, 2% salt, 5% beaten egg and 5% vanilla flavour. During preparation, sugar, flour, baking powder and salt were hand mixed in a plastic bowel. Then, fat was added and the mixture was mixed further by hand until a bread crumb-like mixture was obtained. The mixture was transferred into the food processor (Homeluck). The beaten egg and vanilla flavour were added and the mixture was mixed thoroughly at medium speed for 5 min to obtain the dough. The dough was manually rolled out on a flat and smooth floured board into sheets of uniform thickness of 4 cm and cut with a circular cookie cutter with diameter of 4 cm. The cut doughs were transferred into baking trays lined with grease-proof paper and baked at 180°C for 20 min in a domestic oven (Camara, Italy). Thereafter, the cookies were cooled at room temperature (30±2°C) and divided into two (2) lots. The first lot was subjected to sensory evaluation after 24 h. The second lot was milled and used for chemical analyses. In addition, the cookies made with 100% wheat flour were similarly prepared and used as control.

Chemical analysis

The moisture, crude protein, fat, ash and crude fibre contents of the samples were determined in triplicate according to standard analytical methods (AOAC, 2006). Carbohydrate was calculated by difference of moisture, protein, fat and ash from 100% (Giami, 2005). The niacin, ascorbic acid and folic acid contents of the cookies were determined by the method of AOAC (2006). The thiamin, riboflavin and vitamin A contents of the samples were determined according to the flourimetric method of Onwuka (2005).

Sensory analysis

Semi-trained consumer taste panelists consisting of twenty (20) staff and students selected from the University Community were used to evaluate the sensory attributes of the cookies. During the sensory test, the cookies were individually coded and served to the panelists in white ceramic plates of uniform sizes at room temperature (30±2°C) with cold water for rinsing. The panelists were asked to taste, evaluate and rate the samples for the attributes of crust colour, taste, flavour, texture and overall acceptability using a nine-point Hedonic scale with 1 and 9 representing dislike extremely and like extremely, respectively (Okaka, 2010).

Statistical analysis

The data generated were analyzed statistically by the use of Analysis of variance (ANOVA) and difference between means separated. A completely randomized block design was used in this experiment. SPSS software (version 16.0) was used to determine significant differences ($p \leq 0.05$) among the sample means. Significant means were separated by the use of Duncan's New Multiple Range Test (DNMRT).

RESULTS AND DISCUSSION

Proximate composition

Table 1 shows the proximate composition of wheat-African bread fruit composite cookies. The moisture

Table 2. Vitamin contents of wheat-African bread fruit composite cookies.

Samples	Ascorbic acid (mg/100g)	Niacin (mg/100g)	Thiamin (mg/100g)	Riboflavin (mg/100g)	Folic acid (mg/100g)	Vitamin A (mg/100g)
A	6.47^{a}±0.07	4.26^{a}±0.06	46.48^{a}±0.87	14.22^{a}±0.04	12.26^{a}±0.06	4.32^{a}±0.07
B	2.22^{g}±0.00	2.47^{f}±0.01	28.77^{g}±0.78	9.64^{g}±0.04	7.30^{g}±0.08	0.92^{g}±0.00
C	2.87^{f}±0.07	2.92^{e}±0.10	31.26^{f}±1.42	10.45^{f}±0.03	8.45^{f}±0.06	1.07^{f}±0.02
D	3.55^{e}±0.05	3.14^{d}±0.06	34.89^{e}±0.89	11.16^{e}±0.06	9.03^{e}±0.05	1.20^{e}±0.03
E	3.79^{d}±0.03	3.24^{c}±0.03	36.69^{d}±0.75	11.69^{d}±0.07	9.39^{d}±0.10	1.43^{d}±0.04
F	3.98^{c}±0.07	3.40^{c}±0.03	39.44^{c}±0.39	12.13^{c}±0.05	9.82^{c}±0.09	1.77^{c}±0.06
G	4.13^{b}±0.04	3.72^{b}±0.05	42.22^{b}±0.85	12.68^{b}±0.06	10.20^{b}±0.11	2.11^{b}±0.01

Values are mean ± standard deviation of triplicate determinations. Means in the same column with different subscripts are significantly different (p≤0.05).
A – African bread fruit flour, B – Cookies made with 100% wheat flour, C – Cookies made with 90% wheat flour and 10% African bread fruit flour, D – Cookies made with 80% wheat flour and 20% African bread fruit flour, E – Cookies made with 70% wheat flour and 30% African bread fruit flour, F – Cookies made with 60% wheat flour and 40% African bread fruit flour, G – Cookies with 50% wheat flour and 50% African bread fruit flour.

content of African bread flour was 10.43%. The moisture content of the cookies was between 8-60-9.44% for the control samples (wheat flour cookies) and the cookie samples with 50% African bread fruit flour substitution. The moisture content of the wheat flour cookies was the least, while the cookie samples with African breadfruit flour substitutions had higher moisture contents. The moisture content of the wheat-African breadfruit cookies was comparable with reports on moisture contents of cookies and moisture contents above 10% are likely to affect the storage stability of the products through increased microbial action (Udensi and Akaniyo, 2004; Okpala et al., 2013). The protein content of African bread fruit flour was 13.85%. The protein content of the control samples (wheat cookies) was the lowest, while those with African bread fruit flour substitutions had higher protein contents. This showed that the protein content of the cookies increased as the proportion of African bread fruit flour increased. This observed increase in the protein content of the samples is an indication that African bread fruit is a good source of protein (Osabor et al., 2009; Ojokoh et al., 2013). The fat content of the cookies increased significantly ($p \leq 0.05$) with increasing substitution of African bread fruit flour. This is in agreement with the report that African bread fruit has high oil content (Giami et al., 2004). High fat content in cookies has been reported to cause deteriorative changes in the products during storage due to the problem of peroxidation which is responsible for oxidative rancidity in fat-rich food products (Okoye et al., 2016; Barber and Obinna-Echem, 2016). The ash content of the samples increased as the proportion of African bread fruit flour increased. The high ash content of the samples is an indication that they are good source of minerals (Ariahu et al., 1999). The fibre content of the cookies which ranged from 3.83 to 4.24% was within the recommended FAO/WHO (1994) level of not more than 5% for both children and adults. The carbohydrate contents of all the test cookie samples were lower than the control. This signified that the addition of African breadfruit flour resulted in decrease in the carbohydrate content of the cookies. Such decrease in carbohydrate content of biscuits with increasing substitution of soybean flour has been reported (Okoye et al., 2008). Generally, the substitution of wheat flour with African bread fruit four in the production of cookies greatly enhanced their protein, fat, ash, and fibre contents.

Vitamin composition

Table 2 shows the vitamin contents of wheat-African breadfruit cookies. The ascorbic acid content of the African bread fruit flour was 6.47mg/100g. The ascorbic acid content of the wheat flour cookies was the least, while the test cookie samples with African breadfruit flour substitutions had higher ascorbic acid contents. This showed that the addition of African breadfruit flour resulted in increase in the ascorbic content of the cookies. The observation is an indication that African breadfruit is a good source of ascorbic acid (Fassasi et al., 2003; Ejidike and Ajileye, 2007). The niacin content of the samples which varied from 2.47 to 3.72mg/100g increased significantly ($p \leq 0.05$) as the proportion of African breadfruit flour increased. This is an agreement with the reports that African breadfruit has high niacin content (Nwabueze and Nwokenna, 2000; Okonkwo and Ubani, 2012). The thiamin content of the cookies increased as the level of substitution with African breadfruit flour increased. This showed that African breadfruit is a rich source of thiamin (Ariahu et al., 1999; Ihediohanma et al., 2009). The riboflavin content of the samples increased significantly ($p \leq 0.05$) with increased level of African breadfruit flour in the products. The observation is an agreement with the report that African breadfruit has high riboflavin content (Okorie, 2013).

Table 3. Sensory properties of wheat-African bread fruit composite cookies.

Samples	Colour	Flavour	Texture	Taste	Overall Acceptability
A	7.12^{a}±0.07	7.36^{a}±0.06	7.10^{a}±0.12	7.52^{a}±0.07	7.76^{a}±0.05
B	7.08^{a}±0.08	7.34^{a}±0.09	7.08^{a}±0.08	7.48^{a}±0.05	7.70^{a}±0.07
C	6.76^{b}±0.09	6.38^{b}±0.07	6.56^{b}±0.06	7.66^{b}±0.07	6.76^{b}±0.09
D	6.62^{c}±0.06	6.36^{b}±0.07	6.50^{c}±0.10	6.52^{c}±0.10	6.72^{b}±0.09
E	6.58^{d}±0.11	6.32^{c}±0.08	6.48^{d}±0.13	6.46^{d}±0.13	6.66^{c}±0.07
F	6.48^{e}±0.13	6.26^{d}±0.05	6.30^{e}±0.07	6.44^{d}±0.13	6.52^{d}±0.10

Values are mean ± standard deviation of twenty (20) semi-trained judges. Means in the same column with different subscripts are significantly different (p≤0.05).
A – Cookies made with 100% wheat flour, B – Cookies made with 90% wheat flour and 10% African bread fruit flour, C – Cookies made with 80% wheat flour and 20% African bread fruit flour, D – Cookies made with 70% wheat flour and 30% African bread fruit flour, E – Cookies made with 60% wheat flour and 40% African bread fruit flour, F – Cookies with 50% wheat flour and 50% African bread fruit flour.

There has been similar report on the increase in riboflavin content of cookies substituted with full-fat soybean flour (Iwe, 2002). The folic acid content of the cookies ranged from 7.30 to 10.20 mg/100g with the wheat flour cookies (Sample A) and the test cookie samples with 50% African breadfruit flour substitution (Sample F) having the least and highest values, respectively. The values obtained in this study were higher than the recommended daily intake of folic acid (1.1 - 1.5mg/day) for both children and adults (FAO/WHO, 1994). The vitamin A content of wheat flour cookies (control samples) was the lowest, while the test cookie samples with African breadfruit flour substitutions had higher vitamin A contents. This signified that the vitamin A content of the cookies increased as the proportion of African breadfruit flour increased. Nutritionally, high level of vitamin A is not desirable in human diets because excessive accumulation of this vitamin has been reported to cause vitamin A toxicity in the body (Okaka et al., 2006; Onweluzo and Nwabugwu, 2009). The substitution of wheat flour with African breadfruit flour in the production of cookies had greater effect in enhancing their vitamin contents.

Sensory properties

The sensory properties of wheat-African breadfruit cookies are shown in Table 3. The wheat flour cookies used as control were rated significantly ($p \leq 0.05$) higher than all the test cookie samples for the attributes of colour, flavour, texture, taste and overall acceptability. The cookie samples with 10% African breadfruit flour substitution were not significantly ($p \geq 0.05$) different from the control. Therefore, both the control and the cookies substituted with 10% African breadfruit flour were the most preferred by the panelists. The rating was that of slight likeness. This showed that the level of substitution that was comparable to the conventional wheat flour cookies was 10% and as the level of substitution increased, the level of likeness of the test cookies reduced. In addition, the cookie samples with 50% African bread fruit flour substitution were rated lowest in all the sensory attributes evaluated. In essence, the sensory qualities of the samples can be improved by the use of chemical additives during their production. However, the substitution of wheat flour with African bread fruit flour at a level up to 50% produced good and appreciable results.

Conclusion

The proximate composition and the vitamin content of the wheat-African bread fruit cookies observed in the study showed that African bread fruit flour has the potential to be used as a partial substitute for wheat flour in the production of cookies at the levels of 10 to 50% because of its high nutrient density. The cookie samples substituted with African breadfruit flour generally had higher protein, ash, fat, fibre and vitamin contents than the wheat flour cookies (control). In addition, the cookies with 10% substitution of African breadfruit flour were more preferable in terms of the sensory attributes and acceptability than the other test cookie samples. However, further studies should be carried out to determine the nutritional quality, mineral and amino acid profiles and the storage stability of wheat-African breadfruit cookies.

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