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Nutrition Composition and Sensory Properties of Bread and Fufu produced from Cassava (Manihot esculenta) and Mungbean (Vigna radiata) Flour Blends

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Abstract

Objectives: The research article investigated the nutrient composition and sensory properties of bread and fufu produced from cassava-mungbean base flour blends

Methodology: High Quality Cassava Flour (HQCF) and Odourless Fufu Flour (OFF), complemented mungbean flour at different substitution levels 10C:60W:30M (sample A); 20C:50W:30M (sample B); 30C:40W:30M (sample C) and 100% wheat flour (sample D) for bread production. And 50M:50F(sample A); 40M:60F (sample), 30M:70F (sample C), 60M:40F(sample D) and 100% cassava-fufu flour for fufu production. Nutrient (protein, calcium, iron and beta-carotene) composition of the bread samples and proximate (moisture, protein, crude fiber, fat and carbohydrate) and anti-nutrient (tannin, saponin and oxalate) compositions of fufu samples were determined. Sensory properties of bread (taste, appearance, aroma, texture and general acceptability) and fufu (texture, appearance, aroma and general acceptability) samples were also evaluated.

Results: The result showed protein content ranging from 4.97%-9.14% in bread and 0.96%-1.4% in *fufu* products. The moisture content of fufu flour samples was low (7.02%-9.64%). The fufu samples were found to contain low anti-nutrients; oxalate (0.02%-0.17%), saponin (0.13%-0.27%), tannin (0.11%-0.12%) and appreciable calorie yield (1502 KJ-1561KJ). Bread and fufu produced from flour blends of cassava-mungbean base flours were acceptable to the taste panel members, ranking more than 4.0 in all the parameters tasted.

Conclusion: Acceptable bread and fufu with improved nutrient composition were obtained from flour blends of cassava-mungbean. Flour blends of cassava-mungbean is therefore, recommended for adoption at households for bread and fufu production

Keywords: Cassava; Mungbean; Flour blends; Sensory properties; Nutrient composition

Introduction

Human health is determined by various interactive factors including lifestyle (diet and behavior). The productivity of an individual greatly depends on the health status while good health status greatly depends on good nutrition. Diet and nutrition are important factors in the promotion and maintenance of good health throughout the entire life course [1]. Nutrition deals with the use of food nutrients in promoting good health, it also takes into cognizance how foods are selected, processed and utilized.

Improving the health of individuals who consume too-many or too-few calories or inadequate consumption of macro and micro nutrients remain a major challenge for today's world [2]. Food-based strategies are the key to addressing global hunger and malnutrition. Food strategies must not merely be directed at ensuring food security for all, but must also achieve the consumption of adequate quantities of safe and good quality foods that together make up a healthy diet [1]. There is need to identify and evaluate the nutritional qualities of available-underutilized traditional food crops as well as diversify the use of staple food crops in household food production. Dietary diversification is a sure way of producing healthy varieties of food at the household.

Cassava (Manihot esculenta) is a staple that is readily available and vital to Nigerian economic, as the world largest producer [3]. Cassava is the major source of dietary energy for low income consumers in many parts of tropical Africa [4]. It is a constituent of most traditional foods (garri, fufu, tapioca, etc.) in Nigeria, especially in the western and southern region. However, the consumption of cassava products has been implicated in malnutrition due to its very low protein content [5]. Diversifying the use of cassava, especially in complement with available legumes in food production is capable of improving household food and nutrition security in Nigeria.

Mungbean (Vigna radiata) is a food legume with tremendous nutritional benefits, containing appreciable amount of both macro (protein, carbohydrate, fiber, starch) and micronutrients (Vitamin B, C, E, K, iron, zinc, Copper, calcium) [6,7]. Mungbaen is currently cultivated in

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Nigeria, mostly in the Northern region. Mungbean has advantages over other legumes due to its ease of digestibility and less beany flavor and can be consumed by every age group, irrespective of any health problems [8]. In South-east Asia, India, Philippines and China, mungbean is used in diverse ways in meal production ranging from pan cakes, pudding, soup, ice-cream, noodles etc. [9,10]. Therefore, there is need to explore its potentials in traditional meal production in Nigeria.

Bread is a popular food made from wheat flour dough. It is widely consumed in Nigeria and all over the word, with rapid increase in consumption in recent years [11]. Its consumption is becoming steady and increasing in Nigeria. Wheat is important in bread production because of the gluten content which is not present in staple food crops. The technology of composite flours represents an interesting option for the management of costs associated with importation of wheat flour in developing countries where wheat is not cultivated for climatic reasons [12].

Fufu is a traditional food that is widely consumed in the southern and western region of Nigeria. This special traditional food is processed from fermented cassava roots. Fufu is next to garri as an indigenous food of most Nigerians in the south [13].

The use of flour from local staples especially cereals, legumes, roots and tubers as substitute to wheat flour in baking has been promoted [12,14-19]. It is of utmost importance to increase the utilization of legumes and to introduce new legume-based products that will be affordable to low-income groups to reduce poverty and alleviate malnutrition [20]. Some processed foods and snacks are seldom affordable to the majority of the population due to their rigorous processing methods and non-availability of the production materials. Regardless of cost, most processed foods are devoid of important food nutrients such as fiber and micronutrient which are lost during processing [21]. These important nutrients are very essential in promoting good health. The present research is therefore designed to evaluate the nutrient composition of bread and fufu produced from cassava-mungbean base flour blends.

4. Materials and Methods

Research materials

Mungbean was procured from Lagos State. Cassava roots were purchased from Eke Umuagwo market, Odorless Fufu Flour (OFF) was procured from Cassava Processing Unit of the Imo State Polytechnic Umuagwo-Ohaji, while wheat flour and other materials (bakery fat, yeast, salt, sugar, egg) were procured from Relief market Owerri Imo State, all in Nigeria.

Mungbean flour production (for bread)

One kilogram (1kg) of mungbean seed was sorted, picked and toasted in a pan for 20 minutes over a low gas heat.

Roasted mungbean was dry-milled and sieved with a 2 mm sieve.

Processed mungbean flour was stored in an airtight container for further use.

Production of high quality cassava flour (HQCF)

Cassava roots were sorted to remove flaws. Selected roots were peeled and washed with clean water to remove dirt. Soaked in clean water for 15 minutes, to reduce surface mucus. Manually sliced into thin thickness of 2-3 mm to obtain flakes. Cassava flakes were oven dried using locally fabricated Flash dryer at 60°C. Dried cassava flakes were spread on black nylon in room temperature to cool. After, dried cassava flakes were blended into fine particle using Hammer mill. Further spread lightly on a black nylon at room temperature to cool. Finally, sifted (sieved) using 2mm-mesh sifter to obtain HQCF. Bagged in transparent nylon bag for use.

*Processing of cassava flakes and drying must be within 24hours

Cassava-wheat-mungbean flour blends: The HQCF, white wheat flour and mungbean flour were mixed homogenously in the proportions of: 10C:60W:30M (sample A); 20C:50W:30M (sample B) and 30C:40W:30M (sample C). Three different flour blends were obtained including the control sample, 100% wheat flour (sample D).

Flour samples were stored in airtight container for chemical (protein, calcium, iron and beta carotene) analysis and baking of bread.

Production of bread: The standard method of bread production as introduced by Giami et al. [22] was adopted.

Mungbean flour production for fufu: The method introduced by Agugo, Asinobi and Afam-Anene [23] was adopted.

Production of OFF: Cassava roots-harvested and allowed to stay for 72 hours for surface fermentation to take place.

Fermented cassava roots were sorted to remove spoiled roots and scaled.

The outer coats were removed with electro-mechanical peeling machine.

Peeled cassava roots were crushed into fine particles using Attrition Milling Machine,

Bagged and allowed to ferment for 72 hours to reduce cyanide composition.

Fermented cassava paste was dewatered, pulverized, dried at 1500C for 24 hours and milled (Dry Hammer Milling machine) to obtain OFF.

Packaged in an airtight container for further use..

Composite flour of Mungbean-Fufu

Odorless fufu flour was mixed homogenously with mungbean flour at different proportions; Sample A (50M:50F); 40M:60F (B), 30M:70F (C), 60M:40F(D) to obtain four (4) samples including the control sample 100% odourless-fufu flour (sample E). Flour samples were stored in airtight containers for chemical (proximate, and anti-nutrient) analysis.

Two hundred gram (200 g) of each sample was reconstituted with boiling (100°C) water for sensory evaluation

6. Analysis and Evaluation

Chemical analysis

Bread samples were analyzed for protein and micronutrient (calcium, iron and carotene compositions) while Fufu samples were analyzed for proximate (moisture, ash, protein, crude fiber, fat) and anti-nutrient (saponin, tannin and oxalate) following the standard methods. Carbohydrate was determined by difference and energy was calculated following the Atwater method and converted to kilo joule by multiplying with a factor (4.184)

Sensory evaluation

Sensory evaluation was conducted by 30 semi-trained taste panel members (students of Imo State Polytechnic, Umuagwo-Ohaji) who are familiar with the samples (bread and fufu), on a 9-piont Hedonic Scale where 9 represents like extremely and 1 represents dislike extremely [24]. The bread samples were evaluated for taste, appearance, aroma, texture (mouth feel) and general acceptability, while the fufu samples were evaluated for texture (handfeel), aroma, appearance and general acceptability.

Statistical Analysis

The mean of triplicate chemical determination of samples was analyzed in excel spread sheet and presented with standard deviation. While raw scores obtained from sensory evaluation was analyzed using statistical analytical system (SAS) 20.0 version, differences in mean were determined using the Fishers' Lowest Significant Difference (LSD).

Results

The result showed protein content ranging from 4.97%-9.14% in bread and 0.96%-1.4% in *fufu* products. The moisture content of fufu flour samples were low (7.02%-9.64%). The fufu samples were found to contain low anti-nutrients; oxalate (0.02%-0.17%), saponin (0.13%-0.27%), tannin (0.11%-0.12%) and appreciable calorie yield (1502 KJ-1561KJ). Bread and fufu produced from flour blends of cassava-mungbean base flours were acceptable to the taste panel members, ranking more than 4.0 in all the parameters tasted

Samples	Nutrients			
	Crude protein (g)	Iron (mg)	Calcium (mg)	Carotene (µg/g)
A	9.14 ± 1.07	0.08 ± 0.31	0.28 ± 0.35	3.83 ± 0.02
B	8.73 ± 0.01	0.06 ± 0.01	0.17 ± 0.2	4.55 ± 0.44
C	4.97 ± 0.03	0.06 ± 0.74	0.24 ± 0.06	4.17 ± 0.1
D	8.44 ± 0.01	-	-	-
A (10C:60W:30M); B (20C:50W:30M); C (30C:40W:30M); D (100 %W).				
C=cassava flour, W=wheat flour and M=mungbean flour.				

Table 1: Protein and micronutrient composition of bread samples.

Samples	Taste	Appearance	Aroma	texture	General/ Acceptability
A	4.8b	4.2b	5.1ab	4.7b	5.4ab
B	5.0b	5.2ab	5.2ab	4.7b	5.4ab
C	4.4bc	5.0ab	4.1c	4.6bc	5.0b
D	6.0a	6.0a	6.1a	5.9a	6.1a
LSD	1.1	1	0.9	1	0.8
Mean with the same superscript along the same column are not significant (P<0.05). Samples A (10C:60W:30M); B (20C:50W:30M); C (30C:40W:30M); D (100 %WF). C=cassava flour, W=wheat flour and M=mungbean flour. C=cassava flour, W=wheat flour and M=mungbean flour.					

Table 2: Result on sensory evaluation of bread samples.

Samples	Parameters						
	Moisture (%)	**Ash (%)**	**Protein (%)**	**Crude fiber (%)**	**Fat (%)**	**Carbohydrate (%)**	**Energy Kcal/KJ**
A	8.87 ± 0.9	1.67 ± 0.01	1.4 ± 0.06	1.74 ± 0.18	0.95 ± 0.18	85.38 ± 0.95	363(1519)
B	9.64 ± 0.21	1.98 ± 0.06	1.23 ± 0.31	1.95 ± 1.05	1.02. 0.08	84.17 ± 1.02	359(1502)
C	8.33 ± 0.67	1.26 ± 0.01	0.96 ± 0.09	2.19 ± 0.25	0.71 ± 0.13	86.58 ± 0.69	365(1527)
D	8.92 ± 0.66	1.91 ± 0.08	1.99 ± 0.27	2.4 ± 0.07	1.34 ± 0.06	83.45 ± 0.34	363(1519)
E	7.02 ± 0.27	0.44 ± 0.05	0.19 ± 0.06	5.46 ± 0.73	0.46 ± 0.13	86.44 ± 1.24	373(1561)
Standard deviation of means ±. Sample A (50M:50F); 40M:60F (B), 30M:70F (C), 60M:40F(D) and 100 % F (E). F= Odourless *fufu*; M= Mungbean							

Table 3: Proximate composition of Mungbean-Fufu flour.

Sample	Tannin (%)	Oxalate (%)	Saponin (%)
A	0.12 ± 0.08	0.17 ± 1.12	0.27 ± 0.02
B	0.12 ± 0.07	0.08 ± 0.01	0.21 ± 0.02
C	0.11 ± 0.08	0.05 ± 0.43	0.17 ± 0.01
D	0.11 ± 0.01	0.12 ± 0.64	0.26 ± 0.02
E	0.11 ± 0.01	0.02 ± 0.06	0.13 ± 0.02
Standard deviation of means ± . Sample A (50M:50F); 40M:60F (B), 30M:70F (C), 60M:40F(D) and 100 % F (E). F= Odourless *fufu*; M= Mungbean			

Table 4: Anti-nutrient composition of Mungbean-Fufu flour.

Samples	Parameters			
	Aroma	**Appearance**	**Texture**	**General/acceptability**
A	7.4^{ab}	7.0^{bc}	7.0^{ab}	7.6^{ab}
B	7.5^{a}	7.25^{b}	7.65^{a}	8.2^{a}
C	7.7^{a}	7.2^{b}	6.95^{ab}	$7.2b^{c}$
D	7.1^{ab}	6.65^{bc}	6.2^{b}	6.95^{c}
E	7.65^{a}	8.35^{a}	7.55^{a}	8.05^{a}
LSD	0.12	0.96	1.07	0.87
0.96 Mean with the same superscript along the same column are not significant (P<0.05). Sample A (50M:50F); 40M:60F (B), 30M:70F (C), 60M:40F(D) and 100 % F (E). F= Odourless *fufu*; M= Mungbean				

Table 5: Sensory properties of Mungbean-*Fufu* **.**

Discussion

The protein content (4.97 g-9.14 g) of bread samples from cassava-wheat-mungbean flour blends as shown in Table 1, were higher than the range (4.6 g-7.44g) reported by Umeakuka, et al. [25]in bread produced from Sweet potato-wheat flour blends and the range (2.45 g-2.7g) reported in bread samples produced from Hausa potato-wheat flour blends [16], but agrees with the level (7.01%-8.39%) in bread produced from composite flour of wheat, plantain and soybean [12]. Composite flour with enhanced protein content is a better option for bread production due to its high demand, especially by growing children. Appreciable amount of beta carotene (precursor of vitamin A) was found in the bread samples (3.83 μg/g-4.55 μg/g), though lower than the level reported in bread produced from Sweet potato-wheat flour blends [25]. Calcium and iron content of the bread samples were low. In contrast to this finding higher calcium (26.19mg-98.08mg) and iron (0.16 mg – 0.34 mg) have been reported in bread samples from composite flour of sweet potato-wheat [25, 26].

The sensory evaluation result (Table 2) revealed that scores obtained from the sensory attributes of bread sample from 100% wheat flour ranked highest in all the parameters (taste, appearance, aroma, texture and general acceptability) tasted, though not significant (p<0.05) in some of the parameters, except in taste and texture. For instance, the aroma, appearance and general acceptability of bread from 100% wheat flour is not significant (p<0.05) from the bread produced from flour blend of 10C:50W:30M. The taste of bread from 100% wheat flour was significantly (p<0.05) higher than the rest of the bread samples. This finding agrees with the report of previous researches on sensory attribute of bread produced from 100% wheat [16, 25]. This may be due to the fact that the taste panel members are used to bread produced from wheat flour.

The proximate analysis result (Table 3) shows that the moisture content of mungbean-fufu flour were low (7.02%-9.25%), even lower than the 14% level that is recommended for flour sample of this nature. Flour with greater than 14% moisture is not stable at room temperature. Organisms naturally present in the flour will start to grow at high moistures, producing off odors and flavors [27]. The level of moisture observed from mungbean-fufu blends were higher than the moisture (6.5%-7.3%) content reported by Bamidele, Fasogbon and Oladiran [28] in fufu from cassava-cocoyam blend and fufu from Cassava Mosaic Disease (CMD) Resistant Cultivars [4]. Lower moisture content of foods inhibits the development of contaminating micro-organisms whose growth activities are favoured by the presence of high moisture [29]. According to [30], moisture content of foods influences their shelf stability, the lower the moisture, the better the storage ability of the food products. The protein content of mungbean-fufu slightly improved, higher than the level found in the 100% cassava-fufu flour. Bamidele et al. [28] reported higher protein content (1.68%-4.96%). Protein content of samples increased with increase in mungbean composition. Interestingly, 100% cassava-fufu flour has the highest fiber content, higher than the level (1.42%-4.56%) reported by previous researchers in cassava-cocoyam fufu [28], in fufu (0.01%-0.14%) produced from CMD Resistant Cultivars [4] and in mungbean –garri diet (1.90 g-2.04g) [23]. The processing method (blending into fine flour without sieving) of odourless cassava-fufu flour may have contributed to the high fiber content. Highest carbohydrate content and calorie yield was found with 100% cassava-fufu flour. This may be due to the nature of cassava. Cassava roots contain mainly carbohydrates, of which 80% is starch, the level of protein (1-2%) and fat (less than 1%) are not nutritionally significant [31] sited in [4].

From Table 4, it was found that, the anti-nutrient (tannin and oxalate) composition of fufu blends were higher than the level reported in earlier researches [23,28] but still within the acceptable limit for ready-to-eat foods. According to Stevenson et al. [32] many anti-nutrients have antioxidants and anticancer actions, so avoiding them entirely is not recommended. Lower oxalate (0.02 g) and saponin (0.13 g) composition were found in the 100% cassava fufu flour. The fermentation processes applied in the production of cassava-fufu flour (72 hours) and mungbean flour (16 hours) may have contributed to the low level of anti-nutrients found in the samples. According to Ojo and Akande [33], soaking has an influence in reducing the antinutritional factor of food.

The sensory evaluation result (Table 5) shows that fufu obtained from 100% cassava ranked highest in all the parameters (aroma, appearance, texture and general acceptability) tasted, though not significant (p<0.05) from the other samples in some parameters. The sensory score for texture of fufu from 100% cassava was not significant (p<0.05) from the texture of fufu from blends of 50M:50F, 40M:60F and 30M:70F. The appearance of fufu obtained from 100% cassava flour was significantly (p<0.05) higher than fufu from mungbean-fufu blends. Although appearance is an important sensory attribute of any food, because of its influence on acceptability among consumers [34], there was no significant different in the general acceptability of fufu from 100% cassava and mungbean-fufu from 50M:50F and 40M:60F composition levels.

Conclusion

This research further confirmed the fact that acceptable traditional food with better nutritional quality like bread and fufu can be processed from mungbean in complement with cassava. Diversifying the processing of locally available food will result in availability of more nutritious foods on the table, especially at household level.

The researchers therefore, recommend the use of composite flour of cassava and mungbean in bread and fufu production.

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