QUALITY ASSESSMENT OF CUPCAKE PRODUCED FROM WHEAT-GARRI FLOUR BLENDS

Abstract: Cupcakes were created with composite flour, which included garri and wheat flour blends. The wheat and garri flours were combined in the following ratios: 100:0, 90:10, 80:20, 70:30, 60:40, 50:50, and 0:100, with designations A, B91, C82, D73, E64, F55, and G, respectively. The functional qualities of the composite flours were investigated, whereas the sensory and micronutrient aspects of the cupcakes were examined. The moisture, crude fibre, fat, carbohydrate and protein of the wheat, wheat and garri flour blends, and garri flour ranged from 13.45% to 14.41%; 2.6% to 7.81%; 0.16% to 0.92%; 67.31% to 70.38% and 10.61% to 7.65% respectively. It was observed that as the quantity of garri increased, the moisture content, protein and fat content decreased while the crude fibre, ash and carbohydrate content increased. Bulk density, water absorption capacity, oil absorption capacity and swelling capacity of the flour blends ranged from 0.635g/cm^{3}to 0.765g/cm^3, 11.32% to 26.05%, 13.34% to 15.89%, and 10.43% to 25.39% respectively. Sensory scores of the cupcake demonstrated that acceptable cakes can be made from wheat-garri mixes, particularly at 50% wheat flour and 50% garri flour and 90% wheat flour and 10% garri flour substituting levels.
Keywords: Cake, wheat, garri, composite flour, sensory properties

Introduction

Cake is a renowned bakery product known for its delicious flavor. Cake has become one of Nigeria's most popular non-indigenous snack goods. Wheat flour is one of the most common ingredients used in cake making. Wheat flour is important in baking items because it contains gluten, which is necessary for bakery product quality. However, because wheat production in Nigeria is low, wheat flour is imported to suit the local need of bakers. As a result, wheat imports consume a large amount of foreign exchange each year. To reduce the demand for imported wheat, efforts are being made to encourage the use of composite flour, in which flour derived from locally cultivated goods replaces some of the wheat flour used in bakery items. Cassava (Manihot esculenta crantz) is an important food crop growing in tropical areas (Ceserani and Kinton, 2008). Garri is one of Africa's most popular cassava-based dishes. Garri is a creamy-white, partly gelatinized, roasted, free-flowing granular flour that is widely accepted and enjoyed by Nigerians from all socioeconomic levels because to its high carbohydrate content. Micronutrients (vitamins and minerals) are required for the body's correct operation because the body cannot synthesize them. Micronutrients are required in trace levels and must therefore be obtained through diet (Emojorho et al., 2023a). Composite flour can be made from plantains, cassava, soybeans, and other locally cultivated products (Emojorho et al., 2024a). Attempts have been made to encourage the use of composite flour, which entirely or partially replaces wheat flour in baked goods with flours generated from locally grown crops with high nutritional value. Composite flour technology is the process of combining various forms of flour in a precise quantity with other ingredients, such as cereals and legumes, to produce high-quality food products that completely or partially replace wheat flour in baked goods and pastries. This minimizes the requirement for imported wheat and creates more protein-rich products (Emojorho et al., 2024). Composite flour is created with the goal of increasing the nutritional composition while also encouraging the use of locally available food crops. Composite flour made from grain, legumes, or tubers has been shown to have more nutritional content than flour made from a single food crop (Emojorho et al., 2024). By employing composite flour, we may reduce our reliance on wheat imports for baked goods production, conserve foreign exchange, and engage our youth in productive activities (Anene et al., 2023; Aphiar et al., 2024). The purpose of this study was to develop and test the feasibility of substituting garri with wheat flour, as well as to determine the appropriate substitution level for wheat-garri flour blends in cup cakes.

Material and Methods

Materials: The cassava tubers, wheat flour, margarine, vanilla, eggs, sugar and baking powder were purchased from Nkwo-Ibagwa at Nsukka. Analytical chemicals used for analysis were purchased from a chemical supplier at Nsukka.

Methods

Production of garri flour from cassava tubers: The cassava tubers were peeled, washed, and grated. This was followed by pressing, fragmentation (fermentation for 3 days), granulation (sifting), then drying (roasting/frying), with suitable heat treatment (mostly frying). The roasted (fried) garri was sieved after cooling in order to realize fine particles. Composite flour from wheat and garri flour in different ratio of 100:0, 90:10, 80:20, 70:30, 60:40, 50:50 and 0:100 were blended and designated A, B_{91}, C_{82}, D_{73}, E_{64}, F_{55} and G respectively.

Production of Cupcake from composite flour: The Ceserani and Kinton (2008) method was used to prepare the cake. After cooking, the cakes were allowed to cool in the tin for 5 minutes before being transferred to a steel tray for additional cooling and analysis.

Proximate analysis:

The samples were evaluated for proximate analysis using the method as described by AOAC (2010).

Functional properties

Bulk density was determined by the method of Nyarayana and Narasinga-Rao (1984). Water absorption capacity (WAC) and oil adsorption capacity (OAC) of samples were determined following method of Adebowale *et al*, (2005), Swelling Capacity was determined using the method of Abbey and Ibeh (1988).

Determination of selected micronutrient content of the cake samples: Determination of zinc and calcium using atomic absorption spectrophotometer (AAS) as described by AOAC (2010).

Vitamin Determination

Vitamin B$_1$ (Thiamine) content was determined according to the method of Onwuka, (2005). Beta-carotene content was determined using the method Pearson (1976).

Sensory Evaluation

The cake samples were evaluated for colour, flavor, taste, mouthfeel, texture and overall acceptability using a nine-point hedonic scale.

Experimental design and data analysis

All experiments used a completely randomized design (CRD). The obtained data was analyzed using the analysis of variance (ANOVA) at the 0.05 probability level. Means were compared using Duncan multiple range tests in SPSS version 20.0, with significance considered at $p \leq 0.05$.

Results and Discussion

Table 1: Proximate composition (%) of wheat-garri flour blends

Samples	**Moisture**	**Fat**	**Ash**	**Fibre**	**Protein**	**Carbohydrate**
A	13.62^{a}±.0.007	0.94^{a}±0.098	0.92^{d}±0.000	0.60^{e}±0.014	10.61^{a}±0.00	73.31^{b}±0.080
B$_{91}$	13.23^{a}±0.007	0.81^{b}±0.049	0.88^{d}±0.000	0.75^{d}±0.000	10.03^{a}±0.014	74.66^{b}±0.007
C$_{82}$	13.01^{a}±0.001	0.72^{c}±0.049	0.79^{d}±0.000	0.81^{c}±0.014	9.01^{b}±0.007	75.58^{b}±0.084

D_{73}	$12.67^{b}\pm0.035$	$0.63^{d}\pm0.035$	$0.61^{c}\pm0.014$	$0.87^{c}\pm0.021$	$8.89^{c}\pm0.007$	$76.83^{b}\pm0.028$
E_{64}	$12.25^{b}\pm0.005$	$0.52^{e}\pm0.070$	$0.53^{c}\pm0.049$	$0.96^{b}\pm0.049$	$7.28^{d}\pm0.028$	$78.46^{b}\pm0.041$
F_{55}	$12.01^{b}\pm0.030$	$0.41^{f}\pm0.014$	$0.40^{b}\pm0.007$	$1.01^{b}\pm0.141$	$6.16^{e}\pm0.021$	$80.01^{a}\pm0.028$
G	$11.01^{c}\pm0.010$	$0.26^{c}\pm0.014$	$0.11^{a}\pm0.007$	$1.29^{a}\pm0.021$	$1.04^{f}\pm0.063$	$86.29^{a}\pm0.06$

Values are means of ± S.D of duplicate determinations. Means with different superscript within the same column are significantly different ($p < 0.05$). Keys: A= wheat flour 100:0, B_{91} = wheat-gari blends 90:10, C_{82}= wheat-gari blends 80:20, D_{73}= wheat-gari blends 70:30, E_{64}= wheat-gari blends 60:40, F_{55}= wheat-gari blends 50:50, G= Gari flour 0:100

Table 1 show the proximate composition (%) of wheat, wheat-garri flour blends and garri flour. Sample A (100% wheat flour) and sample G (100% garri flour) had 13.62% and 11.01% for moisture; 0.94 and 0.26% for fat; 0.92% and 6.09% for ash; 0.62% and 1.29 for fibre; 10.61% and 1.04% for protein and 73.31% and 86.29 % for carbohydrate content while the blends ranged from 11.01 to 13.23% for moisture; 0.41- 0.81% for fat; 0.40 – 0.88% for ash; 0.75 -1.01% fibre; 6.16 – 10.03% for protein and 74.66 – 86.29% for carbohydrate. The protein content was comparable to the results of composite flours produced from rice, pigeon pea, and African yam bean reported by Anene et al. (2023) and 3.37% to 11.70% for plantain, rice bran, and mesquite composite flours stated by Emojorho et al., (2024a), but lower than the 18.51% to 36.65% revealed by Emojorho and Okonkwo, (2022). While the ash level was slightly lower than 1.00% to 2.00% for pigeon pea, African yam bean, and rice composite flour reported by Anene et al. (2023) and 1.35 to 1.75% for plantain, rice bran, and mesquite composite flours reported by Emojorho et al. (2024). Increased garri quantity resulted in lower moisture, protein, and fat content ($p < 0.05$), but higher crude fiber, ash, and carbohydrate levels. Cassava is low in fat and protein, which could explain why the mixes' fat and protein levels decreased (Enwere, 1998). According to Ihekoronye and Ngoddy (1985), flour typically includes approximately 14% moisture absorbed from the atmosphere. However, the moisture content of the samples was below the amount that would promote mold formation..

Table 2: Functional properties of wheat, wheat-garri flour blends and garri flour

Samples	Bulk density g/cm^3	Water absorption capacity %	Oil absorption capacity %	Swelling capacity%
A	0.635^c±0.007	11.32^d±0.01	15.89^c±0.010	10.43^c±0.028
B_{91}	0.657^{bc}±0.021	12.15^c±0.04	14.56^c±0.010	11.29^{bc}±0.035
C_{82}	0.665^{bc}±0.007	12.24^c±0.08	14.23^c±0.020	12.48^b±0.030
D_{73}	0.685^b±0.007	12.53^c±0.02	13.84^b±0.010	12.88^b±0.004
E_{64}	0.689^b±0.070	13.10^b±0.09	13.12^b±0.010	13.41^b±0.007
F_{55}	0.691^b±0.000	13.51^b±0.07	12.66^b±0.580	14.12^b±0.021
G	0.765^a±0.007	26.05^a±0.05	10.52^a±0.077	25.39^a±0.020

Keys: Keys: A= wheat flour 100:0, B_{91} = wheat-garri blends 90:10, C_{82}= wheat-garrri blends 80:20, D_{73}= wheat-garri blends 70:30, E_{64}= wheat-garri blends 60:40, F_{55}= wheat-garri blends 50:50, G= Garri flour 0:100

Table 2 compares the functional qualities of wheat, wheat-garri flour blends, and garri flour. The general attributes and industrial applications of food materials are heavily influenced by their functional features (Adeleke and Odedeji, 2010). The functional properties of the sample A (100% wheat flour) and sample G (100% garri flour) were 0.635g/cm3 and 0.765g/cm3 for bulk density (BD); 11.23% and 26.05% for water absorption capacity (WAC); 15.89% and 10.52 % for oil absorption capacity (OAC) and 10.43% and 25.39% for swelling capacity (SC). Samples A and G recorded the lowest and highest scores respectively in all the functional properties evaluated. This implies that garri absorbs more water and oil than wheat flour. Those of the flour blends that ranged from 0.635(g/cm^3) to 0.765(g/cm^3 for BD; 11.32% to 26.05% for WAC; 13.34% to 15.89% For OAC, and 10.43% to 25.39% for SC significantly ($p > 0.05$) increased as the quantity of garri flour increased. The bulk density of the flours were similar to 0.66 to 0.76% for pigeon pea, black gram, and composite flour reported by Anene et al. (2023), 0.64 to 0.66 g/cm^3 for Afzelia Africana and composite wheat flour reported by Emojorho et al. (2024), and also 0.42 to 0.72 g/cm^3 for orange seed flours reported by Emojorho and Akubor, (2016), but higher than 0.40 to 0.44 g/cm^3 for plantain, rice bran, and mesquite seed flours reported by Emojorho. The high carbohydrate content of the garri flour could account for the observed rise in bulk density of the blends.Bulk density is essential in package design and food handling.According to Malomo et al. (2011), -the capacity to absorb water rises as carbohydrate content increases. WAC measures the product's ability to associate with water in water-limited situations, and it is significant in product bulking and consistency, as well as baking applications (Niba et al.2001). Increased garri flour ratio resulted in considerably lower OAC ($p < 0.05$). This could be due to the glutein in wheat flour's inability to bind oil after it was diluted during the substitution procedure. OAC measures the rate at which protein binds to fat in food formulations (Onimawo and Akubor, 2012). However, the SC of the blends improved as garri flour was added as a substitute, with sample G having the highest SC (25.39%). This could be related to the starch in the garri flour, as SC is evidence of noncovalent interaction between molecules with starch granules as well as an indicator of amylose to amylopectin ratios (Rasper, 1969).

Table 3: Vitamins and minerals contents of the cakes samples

Samples	Vitamin B_1 (mg/100g)	Vitamin A (IU)	Zn (mg/100g)	Ca (mg/100g)
A	$0.315^{a}\pm0.012$	$7.795^{a}\pm0.212$	$0.245^{a}\pm0.245$	$12.583^{a}\pm0.118$
B_{91}	$0.285^{b}\pm0.007$	$7.580^{b}\pm0.0282$	$0.226^{b}\pm0.226$	$12.020^{b}\pm0.212$
C_{82}	$0.245^{c}\pm0.012$	$7.440^{bc}\pm0.056$	$0.211^{bc}\pm0.245$	$11.845^{c}\pm0.063$
D_{73}	$0.195^{d}\pm0.007$	$6.020^{c}\pm0.028$	$0.160^{c}\pm0.160$	$10.895^{d}\pm0.134$
E_{64}	$0.170^{e}\pm0.0041$	$5.570^{d}\pm0.424$	$0.095^{d}\pm0.095$	$9.020^{e}\pm0.141$
F_{55}	$0.13^{d}\pm0.0041$	$4.020^{e}\pm0.014$	$0.057^{e}\pm0.047$	$4.685^{f}\pm0.212$
G	$0.035^{f}\pm0.007$	$0.995^{f}\pm0.007$	$0.018^{f}\pm0.07$	$1.156^{g}\pm0.070$

Values are means of ± S.D of duplicate determinations. Means with different superscript within the same column are significantly different ($p<0.05$).Keys: A= Cake produced from wheat flour 100:0, B_{91}= Cakes produced from wheat-gari blends 90:10, C_{82}= Cakes produced from wheat-gari blends 80:20, D_{73}= Cakes produced from wheat-gari blends 70:30, E_{64}= Cakes produced from wheat-gari blends 60:40, F_{55}= Cakes produced from wheat-gari blends 50:50, G= Cakes produced from gari flour 0:100

Table 3 shows the mineral and vitamin composition of the cake samples. The values of vitamin B_1, vitamin A, zinc and calcium content of the wheat flour, wheat-garri blends and garri flour ranged from 0.035 to 0.315mg/100g, 7.795 to 0.995 IU, 0.245 to 0.018 mg/100g and 12.583 to 1.156 mg/100g respectively. The vitamin B1 results were higher than 0.03 to 0.07 mg/100g reported for orange seed biscuits by Emojorho et al. (2023) and 0.01 to 0.07 mg/100g for snaks produced from composite flour reported by Aphiar et al., (2024). The cacium content was higher than 3.08 to 4.00 calcium content for composite flour from plantain, rice bran and mesquite seed reported by Emojorho et al., (2024a) but lower than 419.42 to 686.33 mg/100g for biscuits from composite flour reported by Emojorho et al., (2023) and 114.01 to 875.41 mg/100g Calcium reported by Emojorho et al., (2022) for orange seed flours. Since garri flour was low in the above analysed vitamins and minerals, it was observed that increase in garri flour generally led to decrease of these micronutrients of the wheat-garri flour blends. This could be attributed to garri having little or no vitamin B_1 content**.** The unstable nature of vitamin B_1 to heat may have equally affected it negatively. The reasonable quantity of vitamin A observed may be attributed to other component such as eggs added. It was also observed that vitamin A and the minerals (Zn and Ca) were not drastically reduced during baking. This could be attributed to the fact that they are not readily destroyed when exposed to heat (Fenema, 1996).

Table 4: Sensory scores of cup cakes made from garri flour, wheat flour and wheat-garri flour blends

Samples	Taste	Color	Flavor	Mouth feel	Finger feel	After taste	Overall Acceptability
A	$7.9^{a}\pm0.99$	$8.2^{a}\pm1.23$	$8.0^{a}\pm0.64$	$7.9^{a}\pm1.07$	$7.25^{a}\pm1.68$	$7.75^{a}\pm0.91$	$8.0^{a}\pm0.94$
B_{91}	$7.3^{ab}\pm0.34$	$7.7^{b}\pm1.08$	$7.7^{b}\pm0.80$	$7.3^{b}\pm1.08$	$6.96^{c}\pm1.63$	$7.2^{a}\pm1.15$	$7.6^{b}\pm1.23$
C_{82}	$7.0^{ab}\pm0.25$	$7.45^{b}\pm1.05$	$7.3^{bc}\pm0.80$	$7.4^{b}\pm0.88$	$7.05^{b}\pm1.09$	$7.15^{a}\pm0.81$	$7.25^{b}\pm0.85$
D_{73}	$7.2^{ab}\pm0.05$	$7.35^{b}\pm0.87$	$7.55^{b}\pm0.94$	$7.1^{b}\pm1.16$	$7.15^{b}\pm1.30$	$7.25^{a}\pm1.01$	$7.3^{b}\pm0.80$
E_{64}	$6.55^{c}\pm0.07$	$7.55^{b}\pm0.9$	$6.7^{d}\pm1.30$	$6.65^{c}\pm1.38$	$6.85^{c}\pm1.30$	$6.65^{b}\pm0.98$	$7.2^{b}\pm1.05$
F_{55}	$7.45^{ab}\pm0.39$	$8.0^{ab}\pm0.94$	$7.65^{b}\pm0.87$	$7.4^{b}\pm1.35$	$7.30^{b}\pm1.49$	$7.45^{a}\pm1.46$	$7.55^{b}\pm1.60$
G	$4.45^{d}\pm0.76$	$6.4^{c}\pm1.56$	$5.6^{e}\pm1.53$	$4.7^{d}\pm1.89$	$5.3^{d}\pm1.89$	$4.45^{c}\pm1.76$	$5.0^{c}\pm1.29$

Values are means of ± S.D. Keys: A= Cake produced from wheat flour 100:0, B_{91}= Cakes produced from wheat-gari blends 90:10, C_{82}= Cakes produced from wheat-gari blends 80:20, D_{73}= Cakes produced from wheat-gari blends 70:30, E_{64}= Cakes produced from wheat-gari blends 60:40, F_{55}= Cakes produced from wheat-gari blends 50:50, G= Cakes produced from gari flour 0:100

Table 4 shows the sensory scores for cakes made with wheat flour, wheat-garri flour mixes, and garri flour. Samples containing wheat-garri flour blends had similar acceptance ranges across all parameters.Sample (A) was the most desired in terms of overall acceptability, with high ratings in all attributes. This could be due to individual preferences. Overall, the high organoleptic ratings indicate that the cake was well received by the panelists, with the exception of sample G, which had the lowest mean scores.

Conclusion

This study indicates the feasibility of using garri and wheat flour blends for cake baking. Acceptable cakes were created, however consumers preferred cake examples F55 and B91, which had 50% and 10% garri replacements, respectively. As a result, adopting 10% to 50% garri flour in cake production might drastically reduce foreign spending on wheat imports while also producing new cake product varieties.

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