Global Journal of Medical Research: L
Nutrition & Food Science
Volume 16 Issue 2 Version 1.0 Year 2016
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4618 & Print ISSN: 0975-5888

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*Keywords:* *bread, sesame, fortification, quality, shelf-life.*

*GJMR-L Classification:* *NLMC Code: WA 695*

QUALITYCHARACTERISTICSOFBREADSFORTIFIEDWITHSESAMESEED

*Strictly as per the compliance and regulations of:*

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## I. Introduction

Bread is wheat based baked product widely accepted and consumed throughout the world ( O'Brian *et al*, 2003). In Nigeria, wheat is produced in limited quantity while a greater proportion of wheat flour is imported to meet local flour needs for bakery products. Bread is made about 60% wheat as the base material (Akubor, 2003). The impact of various ingredients, other than wheat on sensory and nutritional quality of bread have been extensively studied ( Heinio *et al*., 2003; Barcenas and Rossel., 2005; Plessas *et al*., 2005) Efforts have been made to use composite flours in which flours of high protein grains grown locally replace a portion of wheat flour, thereby decreasing the high cost of imported wheat and at the same time producing protein-enriched bread (Almazan, 1987). Non-wheat flours, particularly of legumes / oilseeds and other high protein seed flours, up to 20%, have been shown to improve baking properties, nutritional and sensory quality of bread (Kallasapathy *et al*., 1985; Misra *et al*., 1991; Doxastakis *et al*., 2002). While nutritionist are more interested in food composition and health related factors, sensory properties are still the most important criteria that consumers stick to when choosing bakery goods (Giami *et al*, 2004).

In this regard, the researchers strives to produce high quality bread of long shelf life from blends of full fat or defatted sesame seed and wheat flours that would meet the recommended nutritional need and sensory requirement of popular consumers. Sesame seeds contain high amount of tocopherol and lignan compounds which give the oil resistance to oxidation (Mohamed and Awati, 1998; Suja *et al*., 2004b). Sesame is cultivated at commercial quantity in many parts of North Central states of Nigeria and is highly valued as soup and snack ingredient among these people. It is collected from these states and exported out of Nigeria to industrialized nations of the Western world (Bedigan, 2003)

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## II. Materials and Methods

### a) Materials

White sesame seed (*Sesamum indicum*) variety was purchased from Akwanga market while wheat flour, sugar, margarine, baking powder, yeast, common salt, vanilla flavour, eggs and Calcium propionate were purchased from commercial stockers in Lafia main market, all in Nasarawa state, Nigeria. All laboratory reagents used were of analytical grade.

### b) Processing of full fat and defatted sesame seed flours

Dried Sesame seeds were dehulled by pounding lightly in a mortar, and then winnowing away the husks. Part (300g) of the nibs (dehulled seeds) was milled to a fine paste using a laboratory mill (Numex Pep Grinding Mill, India) and then oven-dried (55$^{OC}$) for 24h. This was re-milled to sesame seed powder and sieved through 160$\mu$m pore sieve. The remaining 500g of the nibs was ground to a coarse paste. The paste was fat-extracted batch-wise (100g) with n-hexane (1:5, w/v) as proposed by Boadright and Hetiarachchy (1995) and then oven-dried (60$^{OC}$) for 24h. This was then milled into powder and sieved through 160$\mu$m pore sieve. Both the full fat and defatted flours were used to fortify bread.

### c) Flour blend preparation

Commercial wheat flour was blended with 0%, 10% or 20% of either whole or partially defatted sesame seed flour and the blends are shown in Table 1

### d) Preparation of bread

Breads were prepared using the flour blends in Table 1 and other ingredients. The dough was prepared by blending flour (500g) with other ingredients, yeast (15g), sugar (37.5g), salt (12g), calcium propionate (1.5g), nutmeg (2.5g), citric acid (0.25g), fat (25g), egg

(83ml), water ( 200 ml to 268 ml), in a Kenwood mixer (Model A 907D) using the method of Chauhan *et al*. (1992). The dough from each was kneaded repeatedly by pressing, folding, turning and stretching it out to develop. The dough were fermented for about 80 minutes in plastic bowls covered with muslin cloth at room temperature ($26\pm2^{Oc}$); and then later scaled to 150 g pieces. These were proofed for 90 minutes at room temperature and then baked at $200^{oC}$ for 30 minutes. Breads were cooled for 2h and assessed the following day for chemical composition, physical features, and then for sensory properties by 15-member panellists using a 7-point hedonic scale rank order test.

## III. Chemical Analysis

The method of the Association of Official Analytical Chemists (AOAC, 2000) was used proximate analysis. . Moisture content of wheat flour, whole and defatted sesame meal and bread samples was determined by drying subsamples (3g) of each at $121^{OC}$ for 4h in hot air-oven (Astell-Hearson, Great Bratain) at $121^{OC}$ for 4h, and the loss in weight recorded as the moisture content. The micro-Kjeldahl method was used for nitrogen determination and the crude protein contents expressed as N x 6.25. Crude fat was estimated by exhaustive extraction of the samples (5g) using petroleum ether (boiling point $40\text{-}60^{OC}$) in a Soxhlet apparatus. The fat-free samples after ether extraction were digested alternatively with 1.25% $H_2SO_4$ and 1.25% NaOH under specified conditions. The loss in weight on ignition of the residues to white ashes at $525^{OC}$ in a muffle furnace were reported as crude fibre contents while the net weight was recorded as ash (a measure of mineral content) content. The carbohydrate content (excluding fibre) was obtained by subtracting the sum of crude protein, crude fat, crude fibre and ash from the analyse sample of each sample.

Mineral elements were determined in wet-digests of the samples (Walsh, 1971). Calcium, iron and zinc were determined using an atomic absorption spectrophotometer while the phosphomolybdate method of Yen and Pollard (1955) was used to estimate phosphorus content.

### a) *Physical analysis of bread*

Physical properties were evaluated by measuring loaf volume and specific volume. Loaf volume was measured by seed displacement method (Onwuka, 2005) using dehulled sesame seed in place of rape seed. A box of fixed dimensions (3.4x 2.1 x 4.2 cm), with internal volume $30cm^3$ was put into a tray, half filled with dehulled sesame seed, shaken vigorously for four (4) times, and then filled till slightly overfilled so that the overspill fell into the tray. The box was shaken again twice, and then a straight edge was used to press across the top of the box once to give a levelled surface. The seeds were decanted from the box into a receptacle and weighed. This procedure was repeated three times and the mean value for seed weight was noted (B g). A weighed loaf was placed in the box and levelled off as before. The overspill was weighed and from the weight obtained the weight of seeds around the loaf and the volume of seeds displaced by the loaf were calculated using the following formulas:

$$\text{Seed displaced by loaf (L)} = \text{B g + overspill weight-}20.82\text{g}$$

$$\text{Volume of loaf (V)} = \frac{\text{L x } 23.59\text{cm}^3}{\text{B}}$$

### b) *Sensory analysis*

A blind method of analysis was used where bread samples were coded with randomly selected two (2) digits and one (1) letter (Mellgaard *et al*, 1999). The samples were evaluated by twelve-(12)-member trained panellists. The panellist were instructed to evaluate the organoleptic quality (i.e. the colour, texture, flavour and overall acceptability) using a seven-point hedonic scale where7 (seven) represents liked extremely and 1 (one) represents disliked extremely.

Consumer testing was conducted at the home economics sensory analysis laboratory. The products were served to each panellist in similar sample retaining plate. The panellist were instructed to rinse their mouth with clean water which was provided to each of them before and after testing a product to avoid carry over effect.

### c) *Storage Studies*

The storage study of five bread samples with 100% wheat flour, 10 and 20% substituted whole or defatted sesame seed flour were evaluated by 15-member trained panellists who scored for softness, springiness, moisture and flavour on the 2nd, 4th and 6th day of storage at ambient condition ($26\pm2^{oC}$) after baking, using a seven-point hedonic scale.

### d) *Statistical analysis*

Analysis of Variance (ANOVA) was used to test differences of nutritional value and sensory evaluation. Least Significant difference (LSD) test was used to test for significant differences between the samples at ($P< 0.05$).

## IV. Results and Discussion

### a) *Nutrient composition of whole and defatted sesame seed flours*

Table 2 shows the nutrient composition of full fat (FF) and defatted sesame seed flours (DF). The results show significant variations in moisture (6.6 and 8.0%), crude fibre (23.1 and 27.9%), lipid (31.1 and 11.9%), ash (3.4 and 5.4%) and. digestible carbohydrate (31.28 and 48.01%) contents in full fat and defatted sesame seed flour. The minerals calcium, phosphorus, zinc and iron were comparatively higher in the defatted seed flour than in the full fat seed flour. The content of most minerals (calcium, phosphorus, zinc and iron) in both full fat and defatted seed flours were high enough as good food sources of these minerals. Thus, both the full fat and defatted sesame seed flours were rich in most of the needed nutrients, particularly protein, crude fibre and ash, but the defatted seed flour at most instances had higher contents of each of these nutrients. However, the full fat seed flour was comparatively higher in fat (31.1%) content than the defatted seed flour (11.9), precisely due to the incomplete fat extraction. The nutrient, particularly crude protein and fibre, contents of both full fat and defatted sesame seed fours were very high to warrant their consideration for use to complement cereal-based products to meet the recommended daily nutrient intake of human (National Research Council, 1989). Nutrient composition of bread samples prepared with different levels of whole and defatted sesame seed flour.

Table 3 shows the nutrient composition of bread samples fortified with different levels (0%, 10% and 20%) of full fat or defatted sesame seed flours. The moisture content decreased from 27.95% for the control (0% fortification) to 23.60% for the 20% full-fat sesame seed flour-fortified bread sample. Increasing sesame seed flour (full fat and defatted) decreased residual water content of bread samples proportionally. Substituting whole and defatted sesame seed flours for wheat flour increased protein, fibre, ash and mineral content but decreased carbohydrate content of the bread samples. The residual moisture content of the bread samples decreased with increased levels of sesame seed flour (defatted and whole) substituted 10% defatted sesame seed flour for wheat flour increased the protein (11.80%), fat (0.15%), fibre (1.63%), ash (0.90%), calcium (40.00mg/100g) and phosphorus (15.00mg/100g) content to 14.59%, 2.90%, 5.11%, 1.85%, 1.40%, 43.00mg/100g and 19.00mg/100g content respectively in the bread samples. Also substituted 20% defatted sesame seed flour for wheat flour increased the protein content from 11.80% to 14.93%, fat from 0.15% to 3.85%, fibre content from 1.63% to 5.25%, ash content from 0.90% to 1.85% in the bread samples. The digestible carbohydrate contents (55%) in the 100% wheat bread sample decreased to 51.80% in 20% substituted whole sesame seed bread to 48.10% in 20% substituted defatted sesame seed bread samples. Carbohydrate which is abundant in wheat flour was reduced with the low carbohydrate of defatted and whole sesame seed flours. This is a good approach to increase the nutritional quality of bread from such blends over those of 100% wheat flour (Misra *et al*., 1991).

*b) Sensory and physical quality of bread samples*

Table 4 shows the sensory and physical quality of bread samples prepared with different levels (0%, 10%, 20%) of whole and defatted sesame seed flour. Panellists scored the colour of the Bread samples with 0% sesame seed flour had higher (6.07) higher and bread samples with 20% whole sesame seed flour (5.07) lower. The colour, texture, flavour, mouth feel, overall acceptability of all the bread sample did not differ significantly ($p>0.05$). Bread samples with 10% whole sesame seed flour had higher score in terms of texture (5.93), flavour, (5.80), mouth feel (5.80) and overall acceptability (5.80). The defatted and whole (10 and 20%) sesame seed flour bread showed equal acceptability. The bread sample with 100% wheat flour had the least mean loaf volume (8.07) and mean specific volume (2.07) while bread samples with 20% whole sesame seed flour had the highest mean for loaf volume (11.01) and mean specific volume (2.72). Storage (6 days) stability of bread samples fortified with different levels of whole and defatted sesame seed flour.

Table 5 shows the storage stability of bread samples fortified with different levels of defatted and whole sesame seed flour stored at ambient temperature ($29 \pm 2^{O}C$) for 6 days. The O-fat rancidity, moisture, flavour, musty, softness and springiness of the bread samples on the $4^{th}$ (6.43, 1.79, 6.72, 6.85, 2.41, 5.28) and $6^{th}$ day (6.01, 1.77, 5.89, 6.52, 2.41, 1.87) significantly ($P<0.05$) differed from the bread samples of the $2^{nd}$ day (6.15, 3.03, 6.29, 6.40, 1.97, 4.08) respectively. The bread samples on the $2^{nd}$ day (4.08) were springy and became less springy on the $4^{th}$ day (5.28) and $6^{th}$ day (5.08). The bread sample substituted with whole (U4) and defatted (D5) sesame seed flour did not go rancid and were more stable than the control (A1) during the storage period.

## V. Conclusion

It is apparent that substituting defatted and whole sesame seed flour for wheat flour in bread improved the nutrient composition of the product without adversely reducing its sensory quality. Sesame seed is locally available and easily processed into flour for use. It could form a good substitute for dietetic bread with good keeping quality. The colour, texture, flavour and mouth feel were acceptable by the consumers.

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*Table 1:* Flour blends

| Flour blend Ratio | Defatted sesame flour(g) | whole sesame flour(g) | Wheat Flour(g) |
|---|---|---|---|
| W: $FF_0$ (0:100) | 0 | 0 | 500 |
| W: $FF_1$ (10:90) | 0 | 50 | 450 |
| W: $DF_5$ (10:90) | 50 | 0 | 450 |
| W: $FF_2$ (20:80) | 0 | 100 | 400 |
| W: $DF_6$ (20:80) | 100 | 0 | 40 |

*W=Wheat flour, FF= Full fat Sesame seed flour, DF=Defatted sesame seed flour*

*Table 2:* Nutrient compositions of wheat flour, whole and defatted sesame seed flours

| | FF | DF |
|---|---|---|
| Moisture (%) | 6.60±1.10 | 8.00±0.90 |
| Crude protein (%) | 23.07±1.00 | 27.90±1.00 |
| Crude fibre (%) | 12.14±0.06 | 12.20±0.02 |
| Lipid (%) | 31.05±1.70 | 11.89±1.09 |
| Ash (%) | 3.40±0.01 | 5.45±0.01 |
| Digestible carbohydrate (%) | 31.28±1.00 | 46.02±0.90 |
| Calcium (mg/100g) | 70.00±1.90 | 73.00±3.20 |
| Phosphorus (mg/100g) | 31.00±1.80 | 41.00±2.30 |
| Iron (mg/100g) | 0.19±0.00 | 0.29±0.01 |
| Zinc (mg/100g) | 5.90±1.00 | |
| 6.0±1.50 | | |

*ND= Not determined, UF= whole sesame seed flour, DF= Defatted sesame seed flour*

*Table 3:* Nutrient composition of bread samples fortified with different levels of defatted and whole sesame seed flour

| D/UDSF | Control | Whole | Defatted | Whole | Defatted |
|---|---|---|---|---|---|
| % Flour substituted | 0 (A1) | 10 (A2) | 10 (A3) | 20 (A4) | 20 (A5) |
| Moisture | 27.95±2.30 | 24.85±3.00 | 26.65±2.60 | 23.60±1.80 | 23.75±1.90 |
| rude protein | 11.80±0.10 | 12.48±0.90 | 14.59±1.00 | 13.93±0.90 | 14.93±0.90 |
| Crude fibre | 1.63±0.00 | 3.71±0.00 | 5.11±0.00 | 3.44±0.00 | 5.25±0.00 |
| Lipid | 0.15±0.00 | 4.65±0.00 | 2.90±0.01 | 6.80±0.02 | 3.85±0.00 |
| Ash | 0.90±0.00 | 0.95±0.00 | 1.40±0.00 | 1.30±0.01 | 1.85±0.02 |
| Digestible carbohydrate | 55.44±1.80 | 55.28±1.80 | 51.80±1.50 | 50.37±1.90 | 48.68±2.00 |
| Calcium (mg/100g) | 40.00±1.20 | 43.00±1.60 | 43.00±1.10 | 50.00±1.06 | 50.00±2.01 |
| Phosphorus (mg/100g) | 15.00±0.70 | 20.00±0.40 | 19.00±0.80 | 24.00±0.90 | 23.60±1.00 |
| Iron (mg/100g) | 0.24±0.40 | 0.40±1.00 | 0.28±0.95 | 0.30±1.00 | 0.26±0.70 |
| Zinc (mg/100g) | 3.92±1.00 | 4.90±1.20 | 4.70±1.00 | 4.42±1.00 | 4.21±1.20 |

*Values are means ± standard deviation of two determinations.*

*A1, A2, A3, A4 and A5 are bread samples with 0%,10% whole, 10% defatted, 20% whole and 20% defatted sesame seed flour respectively.*

*Table 4:* Sensory and physical quality of bread samples fortified with different levels of whole or defatted sesame seed flour

| | A1 | A2 | A3 | A4 | A5 | Grand mean | LSD | Significance |
|---|---|---|---|---|---|---|---|---|
| % Sesame seed flour | | 10% | 10% | 20% | 20 | | | |
| Colour | 6.07±1.49 | 5.80±1.32 | 5.47±1.59 | 5.07±1.79 | 5.40±1.88 | 5.56±1.62 | 1.12 | 0.51 NS |
| Texture | 5.27±1.71 | 5.93±1.34 | 5.13±1.59 | 5.00±1.89 | 4.87±1.64 | 5.24±1.64 | 0.99 | 0.44 NS |
| Flavour | 5.60±1.64 | 5.80±1.15 | 4.67±1.76 | 4.67±1.84 | 4.20±2.18 | 4.99±1.81 | 0.96 | 0.07 NS |
| Mouth feel | 4.87±2.20 | 5.80±1.32 | 4.33±1.95 | 4.47±2.13 | 4.53±2.26 | 4.80±2.02 | 1.12 | 0.27 NS |
| O/A | 5.33±1.76 | 5.80±1.47 | 5.33±1.59 | 5.00±181 | 4.73±1.98 | 5.24±1.72 | 0.95 | 0.53 NS |
| Loaf volume | 8.04 | 9.97 | 9.20 | 11.01 | 10.65 | 9.77 | 1.42 | |
| Specific volume | 2.02 | 2.38 | 2.42 | 2.72 | 2.58 | 2.43 | 0.34 | |

*Values are means ± standard deviation of two determinations.*

*A1, A2, A3, A4 and A5 are bread samples with 0%,10% whole, 10% defatted, 20% whole and 20% defatted sesame seed flour respectively.*

*Table 6:* Sensory and physical quality of bread samples fortified with different levels of undefatted or defatted sesame seed flour

| % of Sesame Seed Flour | 0 | 10 | 10 | 20 | 20 | Grand mean | LSD | Significance |
|---|---|---|---|---|---|---|---|---|
| D/UDSF | | UD | D | UD | D | | | |
| Colour | 6.07±1.49 | 5.80±1.32 | 5.47±1.59 | 5.07±1.79 | 5.40±1.88 | 5.56±1.62 | 1.12 | 0.51 NS |
| Texture | 5.27±1.71 | 5.93±1.34 | 5.13±1.59 | 5.00±1.89 | 4.87±1.64 | 5.24±1.64 | 0.99 | 0.44 NS |
| Flavour | 5.60±1.64 | 5.80±1.15 | 4.67±1.76 | 4.67±1.84 | 4.20±2.18 | 4.99±1.81 | 0.96 | 0.07 NS |
| Mouth feel | 4.87±2.20 | 5.80±1.32 | 4.33±1.95 | 4.47±2.13 | 4.53±2.26 | 4.80±2.02 | 1.12 | 0.27 NS |
| O/A | 5.33±1.76 | 5.80±1.47 | 5.33±1.59 | 5.00±181 | 4.73±1.98 | 5.24±1.72 | 0.95 | 0.53 NS |
| Loaf volume | 8.04 | 9.97 | 9.20 | 11.01 | 10.65 | 9.77 | 1.42 | |
| Specific volume | 2.02 | 2.38 | 2.42 | 2.72 | 2.58 | 2.43 | 0.34 | |

*Values are means ± standard deviation of three determinations, NS= Not significant. (P> 0.05).O/A= Overall acceptability, D/U DSF= Defatted or undefatted sesame seed flour, D- defatted, UD= Undefatted*

*Table 5:* Storage (6 days) stability of bread samples fortified with different levels of undefatted and defatted sesame seed flour

| | Days | Sample Codes | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | A1 | A2 | A3 | A4 | A5 | LSD | Significance |
| % of undefatted or Defatted Seed flour | | 0 | 10 | 10 | 20 | 20 | | |
| | 2 | 5.87±1.36 | 6.00±1.13 | 6.27±0.59 | 6.33±0.72 | 6.27±0.88 | 0.54 | 0.64$^{NS}$ |
| O-fat rancidity | 4 | 7.00±0.00 | 7.00±0.00 | 7.00±0.00 | 5.40±1.55 | 5.73±1.03 | 0.56 | 0.00*** |
| (Days) | 6 | 7.00±0.00 | 7.00±0.00 | 6.93±0.26 | 4.53±1.89 | 4.60±1.29 | 0.68 | 0.00*** |
| | 2 | 2.80±0.94 | 3.20±0.78 | 3.00±0.54 | 3.07±0.70 | 3.07±0.70 | 0.38 | 0.68$^{NS}$ |
| Moisture | 4 | 1.47±0.91 | 1.40±0.83 | 2.80±0.78 | 1.73±1.22 | 1.53±1.06 | 0.57 | 0.00*** |
| (Days) | 6 | 1.40±0.63 | 1.33±0.49 | 2.80±0.68 | 1.67±0.98 | 1.67±1.05 | 0.46 | 0.00*** |
| | 2 | 6.13±0.74 | 6.07±0.79 | 6.47±0.52 | 6.40±0.51 | 6.40±0.51 | 0.30$^{NS}$ | |
| Flavour | 4 | 6.80±0.41 | 6.87±0.35 | 6.87±0.35 | 6.80±0.41 | 6.27±0.46 | 0.19 | 0.00*** |
| (Days) | 6 | 6.07±0.26 | 5.93±0.46 | 6.00±0.38 | 5.93±0.46 | 5.53±0.83 | 0.34 | 0.00*** |
| | 2 | 6.47±0.64 | 5.93±0.46 | 6.33±0.72 | 6.33±0.49 | 6.47±0.64 | 0.37 | 0.00*** |
| Musty | 4 | 6.93±0.26 | 6.40±0.74 | 6.93±0.26 | 6.93±0.26 | 6.53±0.52 | 0.17 | 0.96$^{NS}$ |
| (Days) | 6 | 6.87±0.35 | 6.93±0.26 | 6.67±0.49 | 6.60±0.63 | 5.67±1.11 | 0.38 | 0.00*** |
| | 2 | 2.00±1.00 | 6.80±0.41 | 1.93±0.79 | 1.87±0.92 | 1.80±0.94 | 0.33 | 0.00*** |
| Softness | 4 | 1.13±0.35 | 2.27±0.70 | 3.40±0.83 | 3.53±0.99 | 3.53 ±0.99 | 0.49 | 0.64$^{NS}$ |
| (Days) | 6 | 1.07±0.26 | 1.13±0.35 | 2.67±0.82 | 4.53±1.19 | 2.67±0.82 | 0.51 | 0.00*** |
| | 2 | 4.07±1.10 | 1.13±0.35 | 3.80±1.08 | 4.27±0.88 | 4.40±0.83 | 0.59 | 0.00*** |
| Springiness | 4 | 6.87±0.35 | 3.87±0.99 | 4.53±1.06 | 6.80±0.41 | 2.67±1.39 | 0.55 | 0.41$^{NS}$ |
| (Days) | 6 | 6.73±0.46 | 7.45±0.26 | 3.47±0.92 | 6.73±0.46 | 2.53±0.92 | 0.49 | 0.00*** |

*Values are means ± standard deviation of two determinations.*

*A1, A2, A3, A4 and A5 are bread samples with 0%,10% whole, 10% defatted, 20% whole and 20% defatted sesame seed flour respectively.*