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Nutrient Composition Of Wheat-Defatted Sesame Bread

Research Article

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Abstract

The study was designed to harness the rich nutrient profile, increase the utilization of white sesame seeds in the bakery industryand boost the nutrition and health status of bread consumers. Standard procedures were used in bread production, nutrient content determinations and data analysis. The result showed that increased substitution of refined wheat flour with defatted sesame seeds flour up to 50% significantly ($p<0.05$) elevated the moisture, protein, fats, fibre and ash contents of the bread samples with a corresponding significant ($p<0.05$) decrease in carbohydrate content. Similarly, substitution of refined wheat flour with defatted sesame seeds flour in bread production improved the mineral elements content of the bread samples by; calcium (112.99 mg/100g), iron (6.71 mg/100g), magnesium (11.51 mg/100), sodium (45.11 mg/100g), potassium (256.68mg/100) and zinc (8.05 mg/100g) when compared to control sample (100%whitebread). The elevated proximate composition and mineral element values of wheat-defatted sesame seeds bread samples is an indication it might improve the nutrition and health status of bread consumers upon consumption. The study has revealed the suitability of defatted sesame seeds flour in bread production.

Keywords: Defatted Sesame Seeds Flour; Bread; Shelf Life, Food-To-Food Fortification; Mineral Elements.

Introduction

The utilization of bakery products as the supplementation vehicle for different nutrients is progressing day by day. Bread has an important role in human nutrition globally. Generally, whole wheat bread is considered to be a good source of energy and irreplaceable nutrients for the human body [1]. However, bread prepared from refined flour is nutritionally much poorer and does not adequately meet the requirements for many macro- or micro-nutrients [2, 3]. Also, wheat protein lacks the balance of essential amino acids- lysine, threonine and valine. Therefore, there have been many on-going investigations on enhancing the nutritive value of bakery products to fulfill the expanding demands of modern dietary habits, considering the products' protein, mineral, vitamin and/or fiber contents [4, 5]. Bakery products, supplemented with various nutritious and protective substances, have been gaining popularity worldwide. Mixed grain, wholegrain breads and related products are even considered as functional foods because they are convenient vehicles for important nutrients and phytochemicals. [6] reported that the development and consumption of such functional foods would not only improve the nutritional status of the general population but also used in the management of persons with degenerative diseases. Various bread types enriched with combinations of whole oilseeds are being readily accepted by consumers. This interest in whole oilseeds relates to their high content of polyunsaturated fatty acids, vegetable protein, phosphorus, iron, magnesium, vitamin E, niacin, folate and phytoestrogens [7].

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Sesamumindicum seedshave been utilized in the production of several food products globally [8]. It seeds contain significant amount of proteins and essential amino acids (glutamic acid, arginine, phenylalanine and leucine) that can be utilized in composite flour production with improved protein content for bread production [9-11]. Its protein consists of essential amino acids which are not only the building blocks of proteins and peptides but also are essential for the synthesis of many bioactive molecules that participate in the regulation of signaling pathways and metabolism in the body [12]. Sesame seeds flour is rich in methionine and cysteine (sulfur-containing amino acids), glutamicacid and arginine [13]. This implies that sesame has protein of high biological value and could contribute meaningfully in meeting the human requirement for essential amino acids [10]. It has been reported that consumption of sesame seeds increased plasma gamma-tocopherollevels and enhanced vitamin E activity which is believed to prevent cancer and heart disease [14]. Thus, making sesame seeds a good food-to-food fortificant of cereal and legume based products [15].

Dietary fibers (polysaccharides, lignans, oligosaccharides (insulin and resistant starches)) are the portions of plant foods that are resistant to digestion by human digestive enzymes [16]. Sesame meal has been reported to be a good source of dietary fiber, calcium, magnesium, iron, phosphorus, zinc, copper, manganese, selenium and vitamin B1. Sesame seed flour therefore may complement processed wheat flour when blended at optimum ratio and used in bread production, to increase fibre and resistant starch [17], important minerals [18] and vitamin contents.

Material and Methods

Source of materials

White sesame seeds (Sesamumindicum L) and refined wheat flour was purchased from Modern market, Makurdi, Benue State, Nigeria.

Defatted sesame seeds flour production

Defatted sesame seeds flour was prepared using the method described by [19] with slight modification. Sesame seeds were sorted, soaked (12 h) in clear tap water at ambient temperature, washed, drained, sun dried for 6 h and milled into flour using attrition mill (Globe P44, China) to obtain full fat sesame seeds flour. The full fat sesameseeds flour was sieved using 0.45mm mesh. Five hundred grams of the flour was defatted in oneliter of petroleum ether for 1 hr. The defatted sesame seeds flour was dried overnight in a fume hood and milled into fine powder using a kitchen blender (Philips, model HR 1702) and stored in plastic containers with lids until needed for further use.

Composite flour blends formulation

The flour blends were produced according to Shittu et al. [20] method. Refined wheat and defatted sesame seeds flour were blended together on percentage dry weight basis into five ratios of 90:10, 80:20, 70:30, 60:40, 50:50 while 100% refined wheat flour served as the control and used in the production of the various breadsamples.

Recipe for bread production

Table 1 below contains the various ingredients and their quantities used in bread production.

Procedure for bread production

The straight dough method was used in bread production [21]. Prior to the actual baking of the breads, baking trials were carried out under laboratory conditions to optimize baking conditions. Composite flours and ingredients were weighed using laboratory-scale (model: CE-4101, Camry Emperor, China). The composite flours and ingredients were thoroughly mixed to optimize consistency in a Kenwoodkitchen mixer (model: A907D, Kenwood, England) at low speed (85rpm) for 5 min,final dough temperature of 30 ± 2°C. The dough was then kneaded and left to proof for 45min, scaled into 105g portions, shaped and put into oiled baking pans. Baking was achieved at 230 ± 2°C in an electric oven (Electric oven 5L-9 Infra-red Food Oven, Hubert, China) for 45min, cooled at ambient temperature, weighed and packaged in transparent polyethylene bags.

Proximate composition determination

The moisture, protein, ash, fat and fibrecontent of the bread samples were determined using [22] method while carbohydrate content was by difference i.e. 100 – (moisture + protein + ash + fat + fibre).

Determination of mineral elements content

The dry ash procedure for elemental analysis using atomic absorption spectrophotometer (AAS) reagents was used in the determination of mineral elements content of the bread samples [22].

Statistical Analysis

The data generated was interpreted by analysis of variance (ANOVA) using SPSS (version 16.0 software Inc. Chicago, USA) as described by [23]. The Duncan's Multiple Range Test was used to determine the level of significance that existed between the mean values.

Results and Discussion

Proximate composition of wheat-defatted sesame seeds bread samples.

The result of the proximatecomposition of sesame flour and wheat-defatted sesame seeds bread samples ispresented in Table 2.The defatted sesame seeds flour had lower moisture (14.51%), protein (22.56%), fats (18.50%) and ash (2.61%) content but higher fibre (1.70%) and carbohydrate (40.12%) content than non-defatted sesame seeds flour. The moisture content of defatted and non-defatted sesame seeds flour was 14.51% and 26.75%, respectively (Table 2). This result was higher than the finding of Mohamed [24], Zebib et al. [25], Anilakumar et al. [26], Makinde and Akinoso [27] who had reported moisture content of 6.79%, 3.75%, 4.0% and 4.81% for sesame flour, respectively. The protein content of defatted and non-defatted sesame flour was 22.56

and 29.35%, respectively. Zebib et al. [25], Makinde and Akinoso [27] had reported higher values of 34.41and 26.79% for sesame flour, respectively, while Mohamed [24], Anilakumar et al. [26] had reported lower protein value of 21.81% and 18.3% for sesame flour, respectively. This variation in protein content of sesame flour could be due to variety, processing and storage condition, growing climate of sesame as well as analytical methods used. The fat content of defatted and non-defatted sesame flour was 18.50 and 34.63%, respectively (Table 2). Nevertheless, Mohamed [24], Makinde and Akinoso [27], Zebib et al. [25], Anilakumar et al. [26] had reported fat levels of 49.55, 47.73, 47.37 and 43.3%, respectively. The variation in fat content could be due to variances in sesame variety and analytical methods.

Fiber content of defatted and non-defatted sesame flour was 1.70 and 1.11%, respectively. However, Mohamed [24], Makinde and Akinoso [27], Zebib et al. [25] had reported higher level of 8.52, 6.62 and 3.76% fiber for sesame flour, respectively. The ash content of defatted and non-defatted sesame flour was 2.61 and 2.83%, respectively.The result of the ash content of defatted and non-defatted sesame flour of this studywas similar to 2.37% reported byMohamed [24] but lower than 4.62% (Makinde and Akinoso [27]) and 5.2%(Anilakumar et al. [26]). The carbohydrate content of defatted and non-defatted sesame flour was 40.12 and 20.34%, respectively,and higher than 10.94% and 9.65% reported by Mohamed [24] and Makinde and Akinoso [27] respectively.

Bread samples with increased defatted sesame seeds flour substitution were found to be nutritionally superior to white bread (control). The result indicate that moisture, protein, fats, fibre and ash content of wheat-defatted sesame seeds bread samples significantly ($p > 0.05$) increased up to 0.75%, 4.72%, 1.28%, 1.43%

Table 1. Recipe for wheat-defatted sesame seeds bread production.

Ingredients	WUA221	WUA222	WUA223	WUA224	WUA225	WUA226
Refined wheat flour (g)	500	450	400	350	300	250
Defatted sesame flour (g)	0	50	100	150	200	250
Sugar (g)	15	15	15	15	15	15
Yeast (g)	2	2	2	2	2	2
Shortening (g)	10	10	10	10	10	10
Salt (g)	1	1	1	1	1	1
Water (ml)	250	240	210	200	170	160

KEY:
WUA221 = 100% Wheat flour bread (control)
WUA222 = 90% Wheat flour: 10% Defatted sesame seeds flour bread
WUA223 = 80% Wheat flour: 20% Defatted sesame seeds flour bread
WUA224 = 70% Wheat flour: 30% Defatted sesame seeds flour bread
WUA225 = 60% Wheat flour: 40% Defatted sesame seeds flour bread
WUA226 = 50% Wheat flour: 50% Defatted sesame seeds flour bread

Table 2. Proximate composition of wheat-defatted sesame seeds bread samples (%).

Sample	Moisture	Protein	Fats	Fibre	Ash	Carbohydrate
WUA221	$9.00^{h} \pm 0.00$	$13.25^{h} \pm 0.00$	$5.72^{h} \pm 0.23$	$2.22^{f} \pm 0.01$	$4.63^{f} \pm 0.00$	$64.74^{a} \pm 0.02$
WUA222	$9.25^{g} \pm 0.00$	$14.36^{g} \pm 0.01$	$6.50^{g} \pm 0.00$	$2.50^{e} \pm 0.00$	$4.72^{e} \pm 0.01$	$62.68^{b} \pm 0.01$
WUA223	$9.30^{f} \pm 0.00$	$16.43^{f} \pm 0.01$	$6.73^{f} \pm 0.01$	$3.13^{d} \pm 0.01$	$5.21^{d} \pm 0.01$	$59.76^{c} \pm 0.05$
WUA224	$9.50^{e} \pm 0.00$	$16.85^{e} \pm 0.01$	$6.75^{e} \pm 0.00$	$3.16^{c} \pm 0.01$	$5.50^{c} \pm 0.00$	$58.20^{d} \pm 0.01$
WUA225	$9.55^{d} \pm 0.00$	$17.04^{d} \pm 0.02$	$6.76^{d} \pm 0.01$	$3.29^{b} \pm 0.01$	$5.53^{b} \pm 0.01$	$57.90^{e} \pm 0.04$
WUA226	$9.75^{c} \pm 0.00$	$17.97^{c} \pm 0.01$	$7.00^{c} \pm 0.00$	$3.65^{a} \pm 0.00$	$6.80^{a} \pm 0.00$	$55.58^{f} \pm 0.01$
Defatted sesame flour	$14.51^{b} \pm 0.01$	$22.56^{b} \pm 0.01$	$18.50^{b} \pm 0.00$	$1.70^{g} \pm 0.00$	$2.61^{h} \pm 0.01$	$40.12^{g} \pm 0.04$
Non-defatted sesame flour	$26.75^{a} \pm 0.00$	29.35a±0.01	$34.63^{a} \pm 0.01$	$1.11^{h} \pm 0.01$	$2.83^{g} \pm 0.01$	$20.34^{h} \pm 0.05$

Means are duplicate determinations. Means in a column with same superscript are significantly not different ($p \geq 0.05$)

Key:
WUA221 = 100% Wheat flour bread (control)
WUA222 = 90% Wheat flour: 10% Defatted sesame seeds flour bread
WUA223 = 80% Wheat flour: 20% Defatted sesame seeds flour bread
WUA224 = 70% Wheat flour: 30% Defatted sesame seeds flour bread
WUA225 = 60% Wheat flour: 40% Defatted sesame seeds flour bread
WUA226 = 50% Wheat flour: 50% Defatted sesame seeds flour bread

Table 3. Mineral elements profile of wheat-sesame bread samples.

Sample	WUA221	WUA222	WUA223	WUA224	WUA225	WUA226	Sesame flour	Sesame meal
Calcium	185.32^{h}±0.01	265.35^{g}±0.01	285.43^{f}±0.01	294.13^{e}±0.01	312.46^{d}±0.01	378.34^{c}±0.01	398.60^{b}±0.02	415.64^{a}±0.02
Iron	4.05^{h}±0.01	5.65^{g}±0.00	6.43^{f}±0.01	7.46^{e}±0.01	8.46^{de}±0.01	12.36^{c}±0.01	15.67^{b}±0.02	17.93^{a}±0.01
Magnesium	122.55^{h}±0.01	134.26^{g}±0.01	137.32^{f}±0.01	139.65^{e}±0.02	141.63^{d}±0.01	145.77^{c}±0.02	175.64^{b}±0.02	195.92^{a}±0.00
Sodium	177.65^{h}±0.01	266.35^{g}±0.01	268.52^{f}±0.01	284.66^{e}±0.01	298.66^{d}±0.01	311.46^{c}±0.01	345.76^{b}±0.01	336.53^{a}±0.01
Potassium	844.53^{h}±0.01	986.85^{g}±0.01	1024.54^{f}±0.01	1052.39^{e}±0.01	1194.06^{d}±0.02	1243.53^{c}±0.01	1345.86^{b}±0.01	1694.36^{a}±0.02
Zinc	15.25^{h}±0.01	17.12^{g}±0.01	18.56^{f}±0.01	19.34^{e}±0.01	20.16^{d}±0.01	25.17^{c}±0.01	35.96^{b}±0.01	41.04^{a}±0.01

Means are duplicate determinations. Means in a row with same superscript are significantly not different ($p \geq 0.05$)

WUA221 = 100% Wheat flour bread (control)
WUA222 = 90% Wheat flour: 10% Defatted sesame seeds flour bread
WUA223 = 80% Wheat flour: 20% Defatted sesame seeds flour bread
WUA224 = 70% Wheat flour: 30% Defatted sesame seeds flour bread
WUA225 = 60% Wheat flour: 40% Defatted sesame seeds flour bread
WUA226 = 50% Wheat flour: 50% Defatted sesame seeds flour bread

and 2.17%, respectively at 50% replacement of wheat flour when compared to white bread (control) values. The proximate composition parameters of wheat-defatted sesame seeds bread samples ranged between 9.25 - 9.75% (moisture), 14.36 - 17.97% (protein), 6.50 - 7.00% (fats), 2.50 - 3.65% (fibre), 4.72 - 6.80% (ash) and 62.68 - 55.58% (carbohydrate).

The increase in moisture content of bread samples of this study could be attributed to increase in fiber content [28, 29]. However, high moisture content of baked products has been associated with short shelf life, as they encourage microbial proliferation that lead to spoilage [30, 28]. The increase in moisture content of the bread samples of this study were in conformity with the findings of Mohamed [24], who reported moisture content of 26.98% in 5% wheat-sesame seeds bread.

The increase in protein content of the bread samples were in agreement with Nadeem et al. [31], Alozie et al. [32], Mashayekh et al. [33] findings, who reported 14.59-15.62%, 15.08-16.72% and 11.8-14% increase in protein content of wheat-sunflower, wheat-bambara nut and wheat-defatted soy breads, respectively. The protein (14.36-17.97%) content of this study were higher than those reported for wheat-sunflower [31], wheat-bambara nut [32] and wheat-defatted soy [33] breads.The rich methionine, cysteine, glutamic acid and arginine content of sesame seeds flour implies the bread samples contain protein of high biological value and could contribute meaningfully in meeting the human requirement for essential amino acids. Protein is a critical nutrient required in the formation of new cells to replace worn out body cells and tissues as well as building frame work for muscles, as lack of adequate protein is marked with stunted growth in man and animals [10].

The fat content of this study was lower than 6.30-13.40% reported for wheat-sunflower bread [31] but higher than 2.18-2.00% (wheat-bambara nut bread) and 1.3%(wheat-defatted soy bread) reported byAlozie et al. [32] and Mashayekh et al. [33], respectively. This could be attributed to differences in flour production methods used in obtaining flour from the oil seeds as well as plant variety. This indicated that the bread samples have the potentials to serve as dense energy food source for people performing high energy demanding tasks [34] and veritable source for fat soluble vitamins (A, D, E and K). The high fat content of the bread samples may affect the shelf stability [35]. High-energy foods tend to have a protective effect in the optimal utilization of other nutrients [36].

The increase in fiber content of this studywas an affirmation of the high fiber (1.70%) content of defatted sesame seeds flour. The fibre content of this study was higher than 1.47-2.44% reported for wheat-sunflower bread [31] but lower than 3.46-4.30% reported for wheat-bambara nut bread [32]. The high fibreand lower carbohydrate content of the bread samples is of health significance in the management of hyperglyceamia in diabetic patients; aid digestion in the colon and reduce constipation often associated with products from refined grain flours. The bread samples may equally serve as functional food that improves bowel micro fauna, gut health, cardiovascular diseases, diverticulosisand cancer [28, 37, 38].

The increase in ash content of this study agreed with the findings of Nadeem et al. [31], Alozie et al. [32], Mashayekh et al. [33], who reported 1.18-1.38%, 4.28-5.97% and 1.1-1.4% increase in ash content of wheat-sunflower, wheat-bambara nut and wheat-defatted soy breads, respectively. The ash content of a food material is a reflection of its mineral elements content required to support the formation of vital body cells, tissues as well as increase immunity to enhance the body defense mechanism.

The decrease in carbohydrate content of this study agreed with the findings of Alozie et al. [32], who reported 63.71-0.92% decrease in carbohydrate content of wheat-bamabara nut breads. The decrease in carbohydrate content of this study is of great health significance. The bread samples could be harnessed in the dietetic management of diabetics, overweight and obese individuals.

Mineral element content of wheat-defatted sesame seeds bread samples

The mineral elements composition of wheat-defatted sesame seeds bread samples were significantly ($p > 0.05$) elevated with every 10% addition of defatted sesame seeds flour when compared to white bread control (Table 3). The mineral elements composition of wheat-defatted sesame seeds bread samples ranged between 265.35 - 378.34 mg/100g (Ca), 5.65 - 12.36

µg/100g (Fe), 134.25 - 145.77 mg/100g (Mg), 266.35 - 311.46 mg/100g (Na), 986.85 - 1243.53 mg/100g (K) and 17.12 - 25.17 µg/100g (Zn). The increase in the content of the individual mineral element between 90:10 (WUA222) bread sample and 50:50 (WUA226) bread sample was 112.99 mg/100g (Ca), 6.71 µg/100g (Fe), 11.52 mg/100g (Mg), 45.11 mg/100g (Na), 256.68 mg/100g (K) and 8.05 µg/100g (Zn).

The non-defatted sesame seeds flour had significantly ($p > 0.05$) higher Ca (415.64 mg/100g), Fe (17.93 µg/100g), Mg (195.92 mg/100g), K (1694.36 mg/100g) and Zn (41.04 µg/100g) content than its defatted sesame seeds flour counterpart. Similarly, defatted sesame seeds flour had significantly ($p > 0.05$) higher Na (345.76 mg/100g) content than non-defatted sesame seeds flour (336.53 mg/100g). The result revealed that defatting of sesame seeds significantly decreased the mineral element content of its flour.

The calcium content of the bread samples increased significantly ($p > 0.05$) with the inclusion of defatted sesame seeds flour. This agreed with the findings of Ibrahim [39] who reported elevations in calcium content of biscuits made from wheat-Quinoa flour blends than whole wheat flour biscuits. The high calcium content of this study might be useful in the management/treatment of calcium deficiency induced Osteoporosis [40] and colon cancer [41, 42]. The calcium content of this study was higher than16.3 mg/100g (rye-sesame bread) and 6 - 20.4 mg/100g calcium reported for fresh commercial breads made from various cereals and grains consumed by students of Lublin University in Poland [43]. Calcium is vital for teeth and bone formation as well as the regulation of nerve and muscles function [44]. The iron content of this study was higher than 5.45 mg/100g (rye-sesame bread), 2.00 mg/100g (rye-soybean bread) and 2.50 mg/100g (rye-sunflower bread) reported by Winiarska-Mieczan and Kwiecien [43] as well as 1.68-5.45 mg/100g range for other fresh bread samples consumed by Polish students.

Magnesium values were observed to have increased with the inclusion of defatted sesame seeds flour. This result falls below the Recommended Daily Allowance (RDA) of 420mg/day for men and 310mg/day for women [45]. The magnesium content of this study was higher than the 28.27-28.74g/100g reported by Ndungu et al. [46] as well as 25.2 mg/100g (rye-soybean) and 66.10 mg/100g (rye-sunflower) bread [43]. The high magnesium content of this study may be utilized in the dietary prevention/management of cardiovascular, renal diseases, diabetes mellitus, hypertension as well as toxemia of pregnancy [47]. Magnesium has been reported to reduce high blood pressure, enhance protein synthesis, strong bone formation and insulin release [48, 49].

The sodium content of this study was lower than 350.9 mg/100g (rye-soybean) and 392.50 mg/100g (rye-sunflower) bread samples [43] but higher than 86.33 mg/100g reported for wheat-sesame bread [19]. Sodium and potassiumare vital in the maintenance and balance of body fluid balance, nerve transmission as well as muscle contraction [19]. The sodium contentofthisstudywould provide about 6.8% of the recommended daily intake (RDI) for both men and women within age 19 years and above base on the RDA of 1500mg/day [45]. It should however, be noted that the basic source of sodium in bread is table salt.

The potassium contentof this study ranged from 986.85 -1243.53 mg/100g and higher than 45 -237 mg/100g of the breads consumed by Polish students [43]. Potassium was the most abundant element in all the bread samples. The high potassium and low sodium contents of the bread samples has advantage of protecting consumers against arterial hypertension. Potassium can potentially influence the contraction of smooth skeletal and cardiac muscles and it profoundly affects the excitability of nerve tissue. At optimal plasma levels, potassium is vital in maintaining electrolyte and pH balance of the body [19]. The potassium content of thisstudywas in agreement with the findings of Onoja et al. [50].

The zinc content of this study ranged from 17.12-25.17mg/100g and higher than 1-2 mg/100g reported by Winiarska-Mieczan and Kwiecien [43]. Inadequate intakes of micronutrients (Zinc and Iron) have been associated with severe malnutrition, increased disease conditions and mental impairment [51]. The results of this study showed that the bread samples possess the abilityto contribute substantially to the recommended dietary intake of both macro- and micro- minerals of man.

Conclusions

The proximate composition and mineral elements content of defatted sesame seeds flour and bread samples produced from its blend with refined wheat flour indicated the flour to be rich in protein, fats, fibre and ash (mineral elements). Among the macro mineral elements the flour was a rich dietary source of potassium, calcium and magnesium while a rich dietary source of zinc and iron (micronutrients). Defatted sesame seeds flour appeared to be a good food-to-food fortificant to be harnessed in the bakery industry to combat the scourge of malnutrition.

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