

NUTRITIONAL AND SENSORY PROPERTIES OF BISCUITS BASED ON WHEAT (*Triticum aestivum*), BENISEED SEED (*Sesamum indicum*) AND SWEET POTATO (*Ipomoea batatas*) COMPOSITE FLOUR

*¹Ariyo O., ¹Dudulewa B.I. and ²Atojoko M.A.

¹Department of Human Nutrition & Dietetics, College of Medicine, University of Ibadan, Ibadan, Nigeria

²Department of Science Laboratory Technology, Kogi State Polytechnic, Lokoja, Nigeria

*Corresponding author's email: o.ariyo@ui.edu.ng; Tel: +234803-795-0483

ABSTRACT

This study evaluated the nutritional and sensory characteristics of biscuits produced from wheat/beniseed seed/sweet potato composite flour. Four flour samples from wheat, defatted beniseed and sweet potato flours in the ratios of 100:0:0; 80:10:10; 70:20:10; and 60:30:10, respectively with other ingredients were used to produce biscuits. Samples were analyzed for proximate content, vitamins and minerals, antinutrients, sensory and microbial properties using standard procedures. Data were analysed using descriptive statistics and ANOVA. Crude protein, crude fat, crude fibre, ash, carbohydrate and energy composition of samples ranged from 8.39-12.07 g 100-g⁻¹, 17.52-22.59 mg 100-g⁻¹, 0.60-4.20 g 100-g⁻¹, 1.18-2.29 g 100-g⁻¹, 67.11-60.53 g 100-g⁻¹ and 460.34-491.11 kCal 100-g⁻¹, respectively. Calcium, potassium, magnesium, sodium, phosphorus, iron and zinc contents ranged from 474.50-843.75, 498.75-845.00, 267.50-568.50, 92.50-105.75, 82.25-288.25, 3.88-5.99, and 0.07-0.32 mg 100-g⁻¹, respectively. Beta-carotene, thiamin, niacin and tocopherol contents were 429.20-441.93 µg 100-g⁻¹, 4.03-4.83, 17.87-19.57 and 54.87-62.77 mg 100-g⁻¹, respectively. Most nutrients increased with increasing beniseed substitution levels. Phytate and oxalate contents of samples were within permissible levels. Sensory properties decreased from 7.78-5.60, 7.90-5.00, 7.00-6.53, 6.80-5.83, 7.87-5.23 for colour, taste, crispiness, texture and general acceptability, respectively. Number of colonies were negligible after storage for 21 days. Beniseed (20%) and sweet potato (10%) flours substitution for wheat flour produced acceptable biscuits with higher protein and micronutrient composition and acceptable sensory properties than wholly wheat flour and other composite flour biscuits.

Key words: cookies, sesame seed, sweet potato, composite flour, sensory properties

INTRODUCTION

Snacking remains a popular food habit and may substantially influence energy and nutrients intake (Nwosu, 2013). Snacking has been identified to contribute to the increasing burden of malnutrition as more people tend to replace main meals with snacks (Anyika and Uwaegbute, 2005). In Nigeria, many snacks are cereal flour-based, largely energy dense and low in protein and micronutrients (Akpapunam and Darbe, 1994; Brink and Belay, 2006; Omah and Okafor, 2015). Biscuits are small, thin, low-moisture, crispy cakes made from unleavened dough (Okaka, 2009; Agu and Okoli, 2014), packaged and sold in ready-to-eat form and widely consumed globally by people of all ages. Though biscuits are not main food, their stability, convenience and general acceptability, and hence the frequency and quantity of their consumption (Pérez *et al.*, 2008), make them attractive as a platform for food system improvement.

Traditionally, wheat flour is the major ingredient in biscuits production. Wheat (*Triticum aestivum*) is a widely grown cereal and contains

substantial amount of gliadin and glutenin which confer good baking properties (Okaka, 2005) and therefore used in production of bread, biscuits and several flour-based snacks. In recent times, legislation enforced the use of composite flour in Nigeria to reduce reliance on wheat importation, increase utilization of indigenous crops and lower cost of bakery products (Ayo and Gaffa, 2002; Okpala and Chinyelu, 2011; Agu and Okoli, 2014). Consequently, the use of flours from sweet potato, cassava, millet, sorghum is increasing. However, these crops have low protein and some micronutrients contents compared to wheat. Thus, a neglected opportunity cost of the substitution is the nutritional quality of the bakery products. Despite the well-known nutritionally complementary roles of legumes as good sources of plant protein and limiting amino acids in cereals and some phytochemicals, application of this knowledge in food processing is limited in Nigeria context. Also, many roots and legumes are widely grown in Nigeria, however, their applications in production of biscuits and bakery products remain limited.

Sweet potato (*Ipomoea batatas*) is a good and cheap source of energy, antioxidants, and some minerals and vitamins including carotenoids (Woolfe, 1992; Adubasim *et al.*, 2017; Nnadi *et al.*, 2020). It is also an excellent source of dietary fibre which aids digestion and regulates blood cholesterol (Chukwu *et al.*, 2012; Effah-Manu *et al.*, 2013). Beniseed seeds (*Sesamum indicum*) are tiny, flat oval seeds with a nutty taste and belongs to the *pedaliaceae* family of plants. It is a leguminous staple food among many ethnic groups in Nigeria and cultivated majorly in the middle belt and some northern states (Olanyanju *et al.*, 2006). It is valued as a healthy food additive following reported roles in enhancing plasma gamma-tocopherol and vitamin E activity, thereby preventing cancer and heart disease (Conney *et al.*, 2001).

The leguminous seed is rich in nutrients such as digestible protein with a good array of amino acids and minerals (Fagbemi *et al.*, 2004) and its flour is used in food products as a protein, tryptophan, and methionine supplement (Escamilla-Silva *et al.*, 2003). The chemical composition reflects beniseed seed as an important source of oil (44-58%), protein (18-25%), carbohydrate (13.5%) and ash (5%) (USDA, 2009), calcium (429 mg 100-g⁻¹), phosphorus (732-840 mg 100-g⁻¹), iron (9 mg 100-g⁻¹), niacin (4.5-5.5 mg 100-g⁻¹), and thiamin (1.1 mg 100-g⁻¹) (Abu-Jdayil *et al.*, 2002; USDA, 2003; Arslan *et al.*, 2005), and phytonutrients (Okoronwo *et al.*, 2014). The important role and use of legumes in improving nutritional composition of cereal/ tuber-based products has long been established. However, the use of defatted beniseed and sweet potato flours in different substitution levels constitutes a new set of data on biscuits. Though beniseed and sweet potato also have the potential to contribute antinutritional factors with impact of bioavailability of the micro-nutrients, processing is known to reduce effects of these antinutritional factors (Rehman and Shah, 2005).

Following the increased consumption of biscuits among Nigerian young children and adolescents (Anyika and Uwaegbute, 2005), its potential to promote nutritious food system and increase nutrients intake, and the readily availability of potential crops to optimize nutritional composition of biscuits and contribute to increased use of widely cultivated nutritious food crops, this study was designed to determine the nutritional and sensory characteristics of biscuits produced from wheat, beniseed seed and sweet potato composite flour.

MATERIALS AND METHODS

Materials

Beniseed seeds (Beniseed), sweet potatoes, wheat flour, sugar, salt, margarine, baking powder, milk and egg for the study were randomly purchased from Bodija Market, Ibadan, Oyo State, Nigeria. The

beniseed seeds were stored in jute bags and sweet potatoes in racks at 30 ± 2°C. Wheat flour was heat sealed in high density polyethylene bags until used. Other items were stored at recommended temperature as available on the label. The samples were prepared at the Dietetics Kitchen, Department of Human Nutrition and Dietetics while the analysis of the samples was conducted in the Teaching Laboratory of the Department of Human Nutrition and Dietetics, University of Ibadan and the Research Laboratory of the Institute of Agriculture, Research and Training Institute, Ibadan, Oyo State, Nigeria.

Preparation of Defatted Beniseed and Sweet Potato Flours

The Beniseed seeds were sorted manually to remove extraneous materials, damaged and infected seeds after which the seeds were mixed together and a representative sample was obtained. The seeds were washed with tap water to remove dust and then dried in an oven at 60°C for 6 h. The dried seeds were then ground into a meal using a laboratory mill. The meal was defatted using Soxhlet extractor. The defatted meal was oven dried to obtain the defatted beniseed flour which was sieved to obtain a uniform particle size flour (Figure 1), and then kept in an airtight container until analysis.

Sweet potato flour was produced using the method described by Adeleke and Odedeji (2010) with slight modifications. Each root was washed under tap running water to remove sand and other adhering materials, hand peeled and the edible portion was sliced with a stainless knife into thin slices (1 mm thick). The slices were washed in water and placed in a sieve to drain and then blanched at 70°C for 5 min. to inactivate the enzyme that causes browning and thereafter dried in a conventional hot air oven (GallenKamp & Co, Ltd London). The dried slices were milled in a hammer mill (Model RLA 201 - 80014, UK) to pass through a 40 mm mesh sieve (British standard) to obtain flour. The flour was then packed in a polythene bag and stored at ambient temperature.



Figure 1: Flow chart for the production of defatted Beniseed flour

Formulation of Composite Flour Blend

Respective portions of flour for each formulation were blended in a Kenwood food blender (Model KM 201, England) operated at full speed for 5 min. This was designated wheat/beniseed/sweet potato (WBS) blend. Wheat flour (80, 70 and 60 g) was blended with defatted Beniseed flour (10, 20 and 30 g) and sweet potato flour (10, 10, and 10 g) on a replacement basis in a Kenwood food blender operated at full speed for 5 min. Three composite flour blends were thus formulated in the ratios of 80:10:10; 70:20:10; and 60:30:10 while 100% wheat flour served as the control. All the flour blends were packed in high density polyethylene bags and stored in a refrigerator until used.

Production of Biscuit

Biscuits were produced using the method described by Oyewole *et al.* (1996) with slight modifications. Sugar (70.0 g) was added to margarine (100.0 g) in a bowl and mixed until fluffy. Egg (50.0 g) and milk powder (30.0 g) were added and mixed together. Flour (200.0 g), baking powder (2.0 g), vanilla flavour (0.2 g), was slowly added into the mixture. The mixture was kneaded until dough formation. It was then rolled on a flat rolling board sprinkled with flour. Circular biscuits were cut using a biscuit cutter, and were placed on oiled baking trays and baked at 160°C for 20 min. The biscuits were allowed to cool on a rack and then packed in air-tight polyethylene bags (Figure 2).

Chemical Analysis

Proximate analysis

The method of AOAC (2005) was used to determine the moisture, crude protein, ash, fat and crude fibre contents, while carbohydrate was obtained by difference. The energy value was estimated using the Atwater system by multiplying the proportion of protein, fat, and carbohydrate by their respective physiological energy values and taking the sum of the products (Eneche, 1999). All analyses were carried out in triplicates.

Wheat/Beniseed/Sweet potato flour



Figure 2: Flow chart for the production of biscuits

Mineral contents

Potassium (K), calcium (Ca) and sodium (Na) were analyzed using flame photometry; magnesium (Mg), iron (Fe), manganese (Mn) and copper (Cu) by Atomic Absorption Spectrophotometric and phosphorus (P) content was determined using spectrophotometric method (Ariyo *et al.*, 2021).

Vitamin contents

Beta-carotene and vitamins B₁, B₃ and E contents of the biscuits were determined using the standard procedures of AOAC (2005).

Anti-nutritional determination

Percentage compositions of some antinutrients like oxalates, and phytates were determined by the method described by AOAC (2005).

Microbiological Analysis

One milliliter (1 ml) of each sample was serially transferred into nine milliliters (9 ml) of the sterile diluent (peptone water) with a sterile pipette and shaken vigorously. Serial dilution was continued until 10⁶ dilutions were obtained. Aliquot portion (0.1 ml) of the 10⁶ dilutions was inoculated onto freshly prepared, surface-dried nutrient agar (NA). The same quantity (0.1 ml) of the 10⁴ dilution was inoculated onto potato dextrose agar (PDA). The inoculi were spread with a sterile (hockey stick-like) glass spreader to obtain even distribution of isolates after incubation. Nutrient agar plate was incubated for 24-48 h at 37°C, while potato dextrose agar plate was incubated at ambient temperature (28.0 ± 2°C) for 3-5 days. Total plate count for the nutrient agar was done by counting colonies at the reverse side of the culture plates. Total colony count was expressed in colony forming units per gram (cfu/g). Plate counts for PDA plates was done using hand lens for moulds.

Sensory Evaluation

Each of the biscuit samples were assessed for their sensory attributes using 30 untrained panelists, who were familiar with biscuit quality attributes, were randomly selected from the students of the University of Ibadan, Ibadan, Nigeria. The samples were evaluated for appearance, taste, crispiness, texture and overall acceptability on a 9-point hedonic scale (Like extremely-9, Like very much-8, Like moderately-7, Like slightly-6, Neither like nor dislike-5, Dislike slightly-4, Dislike moderately-3, Dislike very much-2, Dislike extremely-1). The order of presentation of samples to the panel was randomized and bottle water was provided to the panelists to rinse their mouths between evaluations.

Statistical Analysis

Analyses were done in triplicate and results represent the average of triplicate determinations, expressed as mean ± standard deviation. Data obtained were subjected to one-way analysis of variance (ANOVA) using Statistical Package for Social Sciences

(SPSS) Version 20.0 (IBM, USA). Data on sensory evaluation were means with standard deviations of thirty determinations and subjected to one-way ANOVA. Significance was accepted at $p \leq 0.05$.

RESULTS

Proximate Composition of Biscuit Samples

The proximate composition of the biscuit samples is presented in Table 1. The moisture content ranged from 5.78 to 2.22 g 100-g⁻¹ with increasing defatted Beniseed flour composition of the biscuits. There was a significant increase in the protein content from 8.39 in the 100% wheat sample to a range of 8.69-12.07 g 100-g⁻¹ in composite flour samples and content increased with increasing composition of defatted Beniseed flour. Likewise, the fat and fibre content increased from 17.52 and 0.60 g 100-g⁻¹ in the 100% wheat sample to a range of 17.70-22.29 and 1.82-4.20 g 100-g⁻¹, respectively with increasing composition of defatted Beniseed flour. The ash content also increased from 1.18 g 100-g⁻¹ in 100% wheat sample to a range of 1.75-2.89 g 100-g⁻¹ with increase in defatted Beniseed flour substitution. Conversely, the carbohydrate content decreased in the enriched samples except for sample 2 (80:10:10) which was not significantly different from the control. Highest estimated energy value (491.11 ± 0.19 kcal 100-g⁻¹) was observed at 30% defatted Beniseed flour substitution and the lowest (446.85 ± 0.22 kcal 100-g⁻¹) at 10% level.

Micronutrient and Antinutrient Composition of Biscuit Samples

The selected minerals and vitamins composition of the biscuits are presented in Table 2 and the anti-nutrient composition in Table 3. Highest calcium

content was observed at 30% defatted Beniseed flour composition (843.75 ± 5.30 mg 100-g⁻¹) and lowest at 10% substitution (474.50 ± 0.71 mg 100-g⁻¹) as compared to 503.75 ± 1.77 mg 100-g⁻¹ in 100% wheat flour biscuit. Likewise, highest potassium contents were observed at 30% defatted Beniseed flour composition (845.00 ± 7.07 mg 100-g⁻¹) and lowest at 10% substitution (498.75 ± 1.77 mg 100-g⁻¹) as compared to 502.50 ± 3.54 mg 100-g⁻¹ in 100% wheat flour biscuit. Magnesium and phosphorus contents increased with increasing substitution level from 282.50 ± 2.12 and 92.80 ± 0.14 mg 100-g⁻¹ at 10% to 568.50 ± 2.12 and 288.25 ± 1.06 mg 100-g⁻¹ at 30% as compared to 267.50 ± 0.70 and 82.25 ± 0.07 mg 100-g⁻¹ in 100% wheat flour biscuit, respectively. Highest iron content occurred at 10% defatted Beniseed flour composition (5.99 ± 0.02 mg 100-g⁻¹) and lowest at 20% substitution (3.88 ± 0.04 mg 100-g⁻¹) as compared to 4.73 ± 0.04 mg 100-g⁻¹ in 100% wheat flour biscuit. Zinc content declined with increasing substitution with defatted Beniseed flour from 0.16 to 0.07 mg 100-g⁻¹ as compared with 0.32 ± 0.01 mg 100-g⁻¹ in 100% wheat flour biscuit. Beta-carotene content increased with increasing defatted Beniseed flour composition from 436.80 ± 1.15 to 441.93 ± 0.35 µg 100-g⁻¹ as compared to 429.20 ± 0.50 µg 100-g⁻¹ in 100% wheat flour biscuit. Highest thiamin and niacin contents occurred at 20% defatted Beniseed flour composition (4.50 ± 0.20 and 19.80 ± 0.36 mg 100-g⁻¹, respectively) and lowest at 30% substitution (4.03 ± 0.21 and 17.87 ± 0.25 mg 100-g⁻¹, respectively) as compared to 4.83 ± 0.25 and 19.57 ± 0.25 mg 100-g⁻¹, respectively in 100% wheat flour biscuit. There were no significant differences in the phytate and oxalate composition in all the biscuit samples (Table 3).

Table 1: Proximate composition of biscuit samples (g 100-g⁻¹)

Parameter	Sample 1	Sample 2	Sample 3	Sample 4
Moisture	5.78 ± 0.05	3.07 ± 0.01	3.73 ± 0.06	2.22 ± 0.02
Crude protein	8.39 ± 0.13	8.69 ± 0.13	9.70 ± 0.13	12.07 ± 0.05
Crude fat	17.52 ± 0.02	17.70 ± 0.03	19.79 ± 0.02	22.29 ± 0.02
Crude fiber	0.60 ± 0.03	2.00 ± 0.02	1.82 ± 0.02	4.20 ± 0.03
Ash	1.18 ± 0.02	1.75 ± 0.05	2.11 ± 0.01	2.89 ± 0.01
*Carbohydrate	67.11 ± 0.06	68.79 ± 0.08	64.66 ± 0.09	60.53 ± 0.06
Energy Value (kcal/100g)	460.34 ± 1.71	446.85 ± 0.22	475.67 ± 0.27	491.11 ± 0.19

Values are means of 3 determinations ± std. dev. (n = 3). *Carbohydrate was obtained by difference. Sample 1 - biscuits produced from 100% wheat flour, Sample 2 - biscuits produced from wheat/Beniseed/sweet potato flours (80:10:10), Sample 3 - biscuits produced from wheat/Beniseed/sweet potato flours (70:20:10), Sample 4 - biscuits produced from wheat/Beniseed/sweet potato flours (60:30:10)

Table 2: Micronutrient composition of biscuit samples (mg 100-g⁻¹)

Parameter	Sample 1	Sample 2	Sample 3	Sample 4
Calcium	503.75 ± 1.77	474.50 ± 0.71	603.75 ± 1.77	843.75 ± 5.30
Potassium	502.50 ± 3.54	498.75 ± 1.77	655.00 ± 7.07	845.00 ± 7.07
Magnesium	267.50 ± 0.70	282.50 ± 2.12	380.75 ± 1.06	568.50 ± 2.12
Sodium	105.75 ± 2.47	92.50 ± 3.53	101.25 ± 1.76	98.25 ± 1.06
Phosphorus	82.25 ± 0.07	92.80 ± 0.14	151.20 ± 0.21	288.25 ± 1.06
Iron	4.73 ± 0.04	5.99 ± 0.02	3.88 ± 0.04	5.53 ± 0.04
Zinc	0.32 ± 0.01	0.16 ± 0.01	0.14 ± 0.00	0.07 ± 0.01
Beta-carotene (µg 100-g ⁻¹)	429.20 ± 0.50	436.80 ± 1.15	439.60 ± 0.20	441.93 ± 0.35
Thiamin	4.83 ± 0.25	4.27 ± 0.15	4.50 ± 0.20	4.03 ± 0.21
Niacin	19.57 ± 0.25	18.67 ± 0.25	19.80 ± 0.36	17.87 ± 0.25
Tocopherol	54.87 ± 0.31	58.67 ± 0.25	56.50 ± 0.30	62.77 ± 0.12

Footnote as applicable to Table 1

Table 3: Anti-nutrient composition of biscuit samples (mg 100-g⁻¹)

Parameter	Sample 1	Sample 2	Sample 3	Sample 4
Phytate	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00
Oxalate	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00	0.01 ± 0.00

Values are means of three determinations ± std. dev. ($n = 3$). Sample 1 - biscuits produced from 100% wheat flour, Sample 2 - biscuits produced from wheat/Beniseed/sweet potato flours (80:10:10), Sample 3 - biscuits produced from wheat/Beniseed/sweet potato flours (70:20:10), Sample 4 - biscuits produced from wheat/Beniseed/sweet potato flours (60:30:10)

Sensory Properties of Biscuit Samples

The sensory properties of the samples are as shown in Table 4. Mean score of appearance decreased from 7.78 ± 1.29 in 100% wheat flour biscuit to 5.60 ± 1.85 in 30% substitution flour biscuit with increase in percentage substitution with defatted Beniseed flour, and taste significantly decreased from 7.90 ± 1.30 to 5.00 ± 2.35 . No significant difference was observed for crispiness in all the samples with best value achieved for 10% defatted Beniseed flour biscuit. Mean score of texture ranged from 6.80 ± 1.54 in 100% wheat flour biscuit to 5.83 ± 2.00 in 30% substitution flour biscuit. The score for the general acceptability of the biscuits decreased from 7.87 ± 0.97 in 100% wheat flour biscuit to 5.23 ± 2.14 in 30% substitution flour biscuit. The 10% replacement with defatted Beniseed flour was the most accepted in taste and crispiness, 20% defatted Beniseed flour replacement was the most accepted in appearance, texture and overall acceptability while 30% defatted Beniseed flour replacement was significantly different from others in appearance, taste, texture and overall acceptability as it was rated least by the panelists.

Microbial Assessment of the Biscuits Produced

No growth was observed for bacteria on day 7 after the biscuits production. On day 14, 1.3×10 total bacteria count was observed in the control sample only. On day 21, the total bacteria count decreased from 1.4×10 to 1.0×10 with the control having the highest count. However, no growth was observed for mould in all samples (Table 5).

DISCUSSION

In this study, increasing defatted Beniseed flour substitution causes declined moisture, carbohydrate and zinc contents, and increased protein, fat, fibre, ash, calcium, potassium, magnesium, phosphorus, and beta-carotene content of the composite flour biscuits. Also, there was no significant change in phytate and oxalate contents of the biscuits. The sensory properties of the biscuits declined for colour, taste, texture and general acceptability with increasing percentage substitution with Beniseed flour. In addition, no growth was observed for bacteria and mould up to day 14 for the composite flour biscuits and bacteria count was lower than in 100% wheat flour biscuit at day 21.

The decreasing moisture content with increasing defatted Beniseed flour composition of the biscuits is in agreement with the findings on effect of Beniseed seed flour on millet biscuit characteristics by Alobo (2001). The decrease observed in the moisture content of the biscuits could be due to increase in protein content as a result of defatted Beniseed flour addition. This could be an advantage to storage quality (shelf life) and prevention of microbial contamination as most spoilage organisms may not be able to survive. Sanni *et al.* (2006) reported that the lower the moisture content of a product to be stored the better the shelf stability of such product. Hence, low moisture ensures higher shelf stability in dried products. The significant increase observed in the protein content of the biscuits could be due to the addition of flours from Beniseed seed, an oil seed which is noted to be a good source of protein (Olanyanju *et al.*, 2006).

Table 4: Sensory evaluation of biscuit samples

Parameter	Sample 1	Sample 2	Sample 3	Sample 4
Appearance	7.78 ± 1.29^a	6.60 ± 1.57^b	6.67 ± 1.42^b	5.60 ± 1.85^c
Taste	7.90 ± 1.03^a	6.73 ± 1.17^b	6.47 ± 1.80^b	5.00 ± 2.35^c
Crispiness	6.80 ± 1.35^a	7.00 ± 1.58^a	6.53 ± 1.76^a	6.73 ± 2.03^a
Texture	6.80 ± 1.54^a	6.47 ± 1.38^{ab}	6.63 ± 1.50^{ab}	5.83 ± 2.00^b
General acceptability	7.87 ± 0.97^a	6.47 ± 1.48^b	6.50 ± 1.59^b	5.23 ± 2.14^c

Values with the same superscript on the same row are not different ($p > 0.05$). Values are means of three determinations ± std. dev. ($n = 3$). Sample 1 - biscuits produced from 100% wheat flour, Sample 2 - biscuits produced from wheat/Beniseed/sweet potato flours (80:10:10), Sample 3 - biscuits produced from wheat/Beniseed/sweet potato flours (70:20:10), Sample 4 - biscuits produced from wheat/Beniseed/sweet potato flours (60:30:10)

Table 5: Microbial load of biscuit samples (cfu/g)

	Day 7		Day 14		Day 21	
	TBC	TMC	TBC	TMC	TBC	TMC
Sample 1	-	-	1.3×10	-	1.4×10	-
Sample 2	-	-	-	-	1.3×10	-
Sample 3	-	-	-	-	1.0×10	-
Sample 4	-	-	-	-	1.0×10	-

TBC - total bacteria count, TMC - total mould count, Sample 1 - biscuits produced from 100% wheat flour, Sample 2 - biscuits produced from wheat/Beniseed/sweet potato flours (80:10:10), Sample 3 - biscuits produced from wheat/Beniseed/sweet potato flours (70:20:10), Sample 4 - biscuits produced from wheat/Beniseed/sweet potato flours (60:30:10)

This increase in protein content is in agreement with the findings of Ayo *et al.* (2010) with an increase in protein of acha-Beniseed flour biscuit and Ugwuona (2009) who reported increased protein content following substitution of cassava-wheat flour with soy flour. Similarly, Emmanuel-Ikpeme *et al.* (2012) reported an increase in protein content of bread and cake produced from wheat/Beniseed composite flour. Alobo (2006) reported that the beniseed has a good balance of amino acids with a chemical score of 62% and a net protein utilization of 54%. This indicates that consumption of baked products produced from the composite flour would supply significant amount of protein to the body. The fat contents of the biscuits were observed to be generally high. The high fat content of the biscuits could be due to the addition of fat during biscuits production. The fat content, however, increased with increase in replacement percentage of wheat flour; this could be due to addition of sweet potato and defatted Beniseed flours at various proportions. This agrees with the findings of Alobo (2001). However, Ayo *et al.* (2010) reported a non-significant difference in the fat content of biscuit made from defatted beniseed and Acha flour. The result of the ash content of the biscuits agrees with reports of Afolabi *et al.* (2001) and Ayo *et al.* (2010). The increase in the ash content could make the product a good source of minerals as observed by other researchers (Elleuch *et al.*, 2007; Usman *et al.*, 2015). There was an increase in the crude fibre content of the biscuits. This finding agrees with that of Emmanuel-Ikpeme *et al.* (2012) who reported an increase in the crude fibre content of wheat and Beniseed composite flour baked foods. High fiber is beneficial to the body, as it could help to maintain bowel integrity, lower blood cholesterol level, and control blood sugar level. Hence consumption of these products would provide appreciable amount of fiber to the body for proper functioning of the digestive and excretory systems.

The result showed a significant difference in the carbohydrate contents of the biscuits. The decrease could be due to the low carbohydrate content of the added defatted Beniseed flour as has been observed in similar studies using legumes (Okoye *et al.*, 2008; Beugré Grah *et al.*, 2014). According to Messiaen (1992), the higher the protein, fat, ash content, the less the carbohydrate. An increase in the energy value was observed as the proportion of defatted beniseed flour increased except at 20% substitution level. This may be due to the increment of the crude fat content which outweighs the decrease of carbohydrate. The recommended minimum daily requirement of energy for a male and female adult is 2900 and 2200 kcal per day, respectively. A 100 g portion of the biscuits produced can cover about 17% and 22%, respectively of daily requirement of energy for a male and female adult per day.

The mineral contents of the samples were significantly improved except for sodium and zinc. Calcium, potassium, magnesium, phosphorus and iron levels increased by 67.49%, 68.16%, 112.52%, 250.46% and 16.91% respectively in the biscuit samples produced from 60:10:30 ratios compared to the control. In all the samples, potassium content was significantly the highest while zinc was the lowest. The high potassium content can be beneficial to people with hypertension (WHO, 2003) and those who suffer from excessive excretion of potassium through the body fluids. The higher mineral contents of the experimental samples could be attributed to the increasing proportions of Beniseed, which contains high mineral elements. The beta carotene content of the biscuits produced agrees with that of Emmanuel-Ikpeme *et al.* (2012) who reported an increase in vitamin A content of composite flour baked foods. There was a significant increase in the beta carotene and tocopherol content of the samples with sweet potato addition and increasing beniseed level. However, a decrease was observed for thiamin in the enriched samples as well as for niacin except at 20% defatted Beniseed flour substitution level. Beta carotene (pro-vitamin A) levels in these products are significant as a result of the beneficial roles of this vitamin in the body. Vitamin A plays an important role in vision, bone growth, reproduction, cell division and cell differentiation (Russell *et al.*, 2001), and regulate the immune system, which helps to fight off infections by making white blood cells that destroy harmful bacteria and viruses (Ross, 1999). Vitamin A also helps in the healthy lining of the eyes, respiratory, urinary and intestinal tract (Semba, 1999).

There was no significant difference in phytate and oxalate contents in all the biscuits, thereby suggesting the addition of sweet potato and defatted beniseed flour did not cause a substantial increase in anti-nutritional components of the biscuits. Anti-nutrients are generally known to reduce the bio-availability of nutrients in the body. High levels of phytates in human nutrition are toxic and decrease the availability of some minerals (Anuonye *et al.*, 2012) as well as protein, when bound to protein; it induces a decrease of solubility and functionality of the protein and also limits the bioavailability of calcium, magnesium, iron and phosphorus by forming of insoluble compounds with the minerals. Likewise, consumption of high levels of oxalate causes corrosive gastroenteritis, shock, low plasma calcium, high plasma oxalates and renal damage (Kelsay, 1985). However, the levels of phytate and oxalate in the biscuits were low and within the permissible levels of 250-500 mg/100 g (Ekop *et al.*, 2008) and 3-5 mg kg⁻¹ (Schivone *et al.*, 2007).

The declining sensory properties with increase in defatted Beniseed flour substitution level is undesirable. Decline in taste could be due to the bitter taste of some inherent compounds in defatted

beniseed flour particularly at high temperature (Olagunju and Ifesan, 2013). Other changes may be attributed to by-products of reaction between carbohydrate and protein which developed undesirable sensory notes. Generally, wheat flour is known to have a better baking quality than any other type of flour, thus the result is not surprising. Nevertheless, the substitution of wheat flour with Beniseed and sweet potato flours in the biscuit samples still produced acceptable sensory qualities.

Micro-organisms play significant role in determining the shelf life of food products as they are usually responsible for the spoilage of many food items and could cause public health problem. The delay in microbial growth and proliferation in these samples might be due to the low moisture content of the biscuits. Ezeama (2007) reported that microbial proliferation was minimum at low moisture content which conferred high shelf-life stability to biscuits.

CONCLUSION

Defatted Beniseed and sweet potato flours substitution for wheat flour produced acceptable biscuits with high nutritive quality and longer shelf life compared to whole wheat flour. The protein, minerals and beta carotene profiles of the biscuits increased significantly with increasing Beniseed flour substitution levels. Sensory properties at all levels of substitution were acceptable and the most acceptable formulation based on general acceptability score was the biscuit with 20% Beniseed flour level of substitution. Hence, the utilization of Beniseed and sweet potato flours in biscuits production is recommended to increase contribution of biscuits to protein, minerals and beta-carotene intakes among biscuits consumers. This approach could also contribute to the efforts to alleviate malnutrition among school age children in Nigeria and other parts of the world. Lastly, further studies are recommended to optimize the sensory qualities of biscuits prepared by substitution of wheat flour with Beniseed and sweet potato flours.

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AUTHORS' CONTRIBUTIONS

All the authors participated in the conceptualization of the study, Ariyo and Dudulewa developed the methodology, Ariyo and Atojoko validated the methodology, and Dudulewa conducted the sample selection, preparation and analysis under the supervision of Ariyo. Ariyo supervised the entire activities, Atojoko and Dudulewa prepared the first draft, Ariyo reviewed and edited and final manuscript was read and approved by all the authors.

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