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NUTRIENTS AND ORGANOLEPTIC PROPERTIES OF FINGER MILLET (*Eleusine caracana*) BISCUITS ENRICHED WITH SOYA BEAN (*Glysine max*) AND CARROT (*Daususcarota*)

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ABSTRACT

Background: The inability of the country to meet the industrial demand of wheat has necessitated the need for the research into alternative local sources of flour for baking.

Objective: The objective of the study was to evaluate the nutrient and organoleptic properties of finger millet biscuits enriched with soybean and carrot flour blends.

Methods: The study is an experimental design. Finger millet was purchased from a local Market in Brinigwari. Abuja. Soybean commercial wheat flour, carrot, sugar, baking powder and butter were purchased at Ubani, Umuhia Main Market. The method of de wet was adopted for production of finger millet flour. Soybean flour was produced using the method of Alabi while carrot flour was produced using the method described by Marvin. The samples consisted of 100% commercial wheat flour and blends of finger millet, soybean and carrot flour blends in the ratios of 70:20:10, 50:30:20 and 45:45:10 respectively. Creamy method was adopted for biscuits production. The biscuit products were subjected to chemical and organoleptic evaluations. Proximate parameters were evaluated using AOAC methods; Minerals using wet-acid digestion and vitamins determination using spectrophotometric and titration methods. Organoleptic properties were evaluated using a 9-point hedonic scale. The data generated were analysed using Statistical product for service solution version 20, means were separated and compared with Duncan multiple range test and Analysis of Variance.

Results: Moisture, carbohydrate, (7.05%; 68.63%) respectively were significantly higher in 100% wheat biscuit while protein (9.08 – 9.12%), fiber (3.41 – 3.93%), lipid (16.05 – 15 -28%), β-carotene (312.62-346.45mcg), flavonoids (1.91 -1.98mg) and vitamins B_1 (4.71 – 4.82mg), B_2 (8.05 – 8.21mg) and B_3 (2.83 – 2.97mg) respectively were significantly higher in composite biscuits. Mouth feels for samples. 50% finger millet: 30% soybean: 20% carrot powder flour blends(RC) (6.35) and 45% finger millet, 45% soybean: 10% carrot powder flour bends(RD) (6.80) were comparable to that of wheat biscuit while Colour (8.25), texture (7.80) and taste (8.25) of wheat biscuit were more preferred

Conclusion: Biscuits produced from composite flours had higher amounts of protein, fiber, lipid and vitamins values compared to biscuits produced from 100% wheat flour but acceptability was lower.

Keywords: Biscuit, composite flour, finger millet, soybean, carrot

INTRODUCTION

Millets are regarded as important crops due to their resistance to pests and diseases, short growing season, and productivity under hard and drought condition (1). Millet commonly called "African ragi" or "African millet" belongs to two varieties of the grass family, the *Chlorideae* and *Panniceae* (2). Finger millet (*Eleusine coracana*) belongs to the tribe *Chlorideae* (2). It is the most common species of finger millet cultivated for food use; other wild and semi-wild species of this millet are *Eleusine indica* and *Eleusine Africana*. Finger milletranks fourth in importance among millets after sorghum, peal millet and foxtail millet (3).Finger millet is not a common household food in Nigeria as a whole, but in Northern Nigeria it is produced for food, beer and folder (4). Pap prepared from finger millet is reported to be preferred to the ones made from maize and sorghum due to its flavor and high nutritional value (5). Using finger millet for biscuit production may increase its intake as consumption of biscuits has become very popular among all age group in Nigeria (6).Its use for breakfast and for snack is fast replacing locally available foods normally consumed for breakfast and snack in Nigeria. Increased demand for biscuits is attributed to their texture; cheapness and ready-to eat form. Finger millet

is a good source of carbohydrate, calcium (344mg) and magnesium (408mg), dietary fiber and polyphenols (7), but like other cereals it is a poor source of fat, protein and some vitamins.
In other to enhance the nutrient composition of biscuit made from cereals such as sorghum or millet, supplementation using legume and carrot has been suggested (8). A study carried out by Serrem *et al*. (9) reported 200% increased of protein in a sorghum-soy composite biscuits with 1:1 sorghum: Defatted soybean flour over biscuits produced from 100% sorghum.

Soybean (*Glysine max*) belongs to the family leguminosae. It is mainly cultivated as seeds, used commercially as human food and livestock feed, and for the extraction form of oil. Soybean seeds contain 30 to 45% protein with a good source of all indispensable amino acids (9). Its protein is about 2 times of other pulses, 4 times of wheat, 6 times of rice grain, 4 times of egg and 12 times of milk (10). The utilization of soybean in production of composite flours has been reported by many researchers (11; 12; 13).

Carrot (*Doucus carota*)is rich in bioactive compounds like carotenoids and dietary fibers (14). It is also an excellent source of phytonutrients such as phenolics and polyacetylenes (15). In recent years the consumption of carrots and its products have increased steadily due to their recognition as important source of natural antioxidants and as precursor of vitamin A (16) and their use as supplement in products like, bread, cake, biscuits and several other products is on the increase (17).

Finger millet is a member of the millet family known as "ragi" or "tamba" (18). It consists of the brown, light brown and white cultivars (19). The white cultiva was developed mainly for baking industry, the brown and light brown for porridge use and the brown cultivar for brewing of traditional beer (20). Nutritionally every 100g of the grain contains 65 – 75% carbohydrates, 5 – 8% protein, 1 - 2 % fat, and 15 – 20% dietary fiber (21). This work was designed to evaluate the nutrients and organoleptic properties of biscuits produced using finger millet enriched with soybean and carrot flours.

MATERIALS AND METHODS

Procurement of raw materials

One (1kg) kilogram of finger millet (*Eleusine coracana*) was purchased from a local Market in Brinig wari town FCT Abuja, Nigeria. Soybean (*Glysine max*) and carrot (*Daucus carota*) (1kg each) were purchased from in Ubani Market Umuahia, Abia State Nigeria. Refined wheat (1kg), sugar (500g), baking powder and butter used for biscuit making were also purchased from Ubani Market in Umuahia, Abia State.

Production of finger millet flour

The method of de wet (22) was adopted in the production of finger millet flour. One thousand (1000g) grams was winnowed to remove chaff, dirt and stones. The sample was washed with tap water, drained and sun dried for 10hrand then dry-milled milled with a hammer milling machine (model ED-5 Thomas Willy; England). The dried milled flour was sieved through a 100um mesh sieve and package in an air tight container pending usage.

Production of soybean flour

The production of soybean flour was done using the method of Alabi (23).One thousand grams(1000g) soybean was sorted to remove unhealthy seeds, stones and dirt. The seeds were washed using tap water and boiled with 5 cups (1250ml) of water for 30 minutes. The hot water was discarded. The seeds were rinsed and then soaked with 5 cups (1250ml) of cold water for 3 hours to soften the hull for easy removal. The soybean was dehulled, washed and blanched for 10 minutes, drained and dried in an air oven (80^{o}C) for six (6) hours. It was roasted using a steel frying pan at low temperature for 20 minutes until golden (light) brown, it was then cooled, dry milled using a hammer milling machine (model ED-5 Thomas willy; England)grinding and sieved with 100um mess sieve to obtain fine powder and packed in air tight container.

Production of carrot powder

The carrots was washed in potable water, peeled manually using a kitchen knife, sliced manually using a kitchen knife into about 56mm thickness; the sliced carrots was blanched for 3 minutes in hot water to prevent browning and discoloration. It was cooled and then dried in a hot air oven at 60°C for 24 hours. The dried carrots were ground to fine powder using a kitchen blender (Model HL 3294/C Phillips) and sieved with a 0.150 µ sieve.

Blend formulation and ingredients used for preparation of biscuits

The blends were formulated on protein basis. Sample RB (70:20:10 finger millet, soybean and carrot) consisted of 70g finger millet, 20g soybean, 10g carrot, 40g margarine, 30g sugar,1g baking powder, 0.5g flavor (vanilla), 10g egg, and 10g milk. Sample RC (50:30:20 finger millet, soybean and carrot) consisted of 50g finger millet, 30g soybean, 20g carrot, 40g margarine, 30g sugar,1g baking powder, 0.5g flavor (vanilla), 10g egg, and 10g milk. Sample RD (45:45:10 finger millet, soybean and carrot) consisted of 45g fingermillet, 45g soybean, 10g carrot, 40g margarine, 30g sugar,1g baking powder, 0.5g flavor (vanilla), 10g egg, and 10g milk. While sample RA (100% wheat (control)) contained 100g wheat, 40g margarine, 30g sugar,1g baking powder, 0.5g flavor (vanilla), 10g egg, and 10g milk.

Preparation of biscuits

Creaming method was adopted for the production of the biscuits. Sugar and margarine were mixed manually with a wooden spatula until the mixture became fluffy; egg, milk and flour mixed baking powder were added alternatively and mixed until smooth dough was formed. The dough was then spread uniformly to a thickness of about 0.25cm over a board using a rolling pin. Biscuit cutter was used to cut the sheet of rolled dough into desired shapes and size. The cut pieces was placed over a greased baking tray and transferred into a preheated laboratory oven at 160°C for 20 minutes (BCH- Rotary oven. Great Britain). The biscuits were cooled to room temperature (30°C) and stored in air tight container for further analysis.

Chemical analyses of the samples

The proximate compositions of the biscuits were determined using standard AOAC (24) methods. Moisture content was determined gravimetrically. The crude protein content was determined using micro-Kjeldahl method, 6.25 was used as the nitrogen conversion factor. The crude fat content was determined using Soxhlet extraction method. The ash content was determined by incinerating the samples at 600^0C in a muffle furnace. Carbohydrate was obtained by difference, while energy was calculated using the Atwater Conversion factors in KJ and Kcal (17KJ per 4Kcal, 17KJ per 4Kcal, and 37KJ per 9Kcal, for protein, carbohydrate and lipid respectively).

Mineral elements were determined using wet-acid digestion method for multiple nutrients determination as described by the method of AOAC (24). The digest was used for the determinations of calcium (Ca) and magnesium (Mg) using the ethylamine ditetra acetic acid (EDTA) Versanate complexiometric titration method. Potassium (K) and sodium (Na) were evaluated using flame photometry method and phosphorus (P) by the vanadomolybdate method using the spectrophotometer (Model 3030, Perkin Elmer, Norwalk USA). Microminerals (Zn, Fe) were by Atomic Absorption Spectrophotometer (Model 3030 Perkin Elmer, Norwalk USA).

The β – carotene, riboflavin, niacin and thiamin of the products were determined spectrophotometrically as described by AOAC (25), while ascorbic acid was determined as described by AOAC (24) using titration method.

Sensory evaluation

Sensory evaluation of the products was carried out by a group of 20 untrained panelists randomly selected from the Department of Human Nutrition and Dietetics. The evaluation was carried out in the food laboratory of the Department. The judges evaluated the products using anine point hedonic scale where 9 = like extremely and1 = dislike extremely. Panelists scored the sample for four sensory attributes – colour, flavor, taste and over all acceptability. A cup of potable water was given to the panelist to rinse his/her mouth after each tasting.

Statistical analysis

The data generated from duplicate analysis were keyed into the computer and analyzed using Statistical product for service solution (SPSS version 20). Means and standard deviations were calculated. Analysis of Variance (ANOVA) was used to compare the means and mean separation was done using Duncan multiple range test. All calculations were done at 5% level of significance ($p< 0.05$).

RESULTS

Energy and proximate composition of biscuits produced with finger millet, soybean and carrot flour blends

Energy and proximate composition of the samples are presented on Table 1. Moisture was low in all the samples. Moisture content of biscuits produced with 100% wheat flour was however significantly higher (7.05%) than moisture obtained from biscuit produced from composite flour (6.81 – 6.97%). Crude protein (9.21 – 9.68%), crude fiber (3.41 – 3.92%), crude lipid (15.28 – 16.22%) and ash (2.59 -2.81%) were significantly ($p<0.05$) higher in biscuits produced from the composite flour while carbohydrate was significantly higher (68.63%) biscuits produced from 100% wheat flour. Energy was higher in biscuits produced from 50% finger millet, 30% soybean, 20% carrot (426.62kcal).

Energy and proximate composition of biscuits produced with finger millet, soybean and carrot flour blends

Proximate composition (%)	Sample RA	Sample RB	Sample RC	Sample RD
Moisture content	7.05^a±0.03	6.81^c±0.01	6.93^b±0.02	6.97^b±0.02
Crude protein	6.82^d±0.02	9.21^c±0.01	9.39^b±0.02	9.68^a±0.01
Crude fiber	2.73^d±0.02	3.92^a±0.02	3.63^b±0.02	3.41^c±0.02
Crude lipid	12.64^d±0.02	16.05^a±0.01	15.90^b±0.01	15.28^c±0.01
Ash content	2.15^d±0.02	2.81^a±0.01	2.67^b±0.01	2.59^c±0.01
Carbohydrate	68.63^a±0.01	61.22^d±0.02	61.22^d±0.02	62.10^b±0.01
Energy (kcal)	415.50^d±0.16	426.11^b±0.05	426.62^a±0.13	424.56^c±0.13

Values are mean ± standard deviation of 2 replicates. Mean within each column not followed by the same superscript are significantly different (P>0.05) from each other.
Keys:
RA = 100% wheat flour,
RB = 70% finger millet: 20% soybean: 10% carrot powder flour blends,
RC = 50% finger millet: 30% soybean: 20% carrot powder flour blends,
RD = 45% finger millet, 45% soybean: 10% carrot powder flour bends.

Minerals composition of biscuits produced with finger millet soybean-carrot flour blends

Minerals composition of the products is shown in Table 2. Macro-minerals were generally low in all the samples. Calcium (18.45mg/100g) and phosphorus (30.76mg/100g) were significantly higher in biscuits produced with 100% wheat flour. Sodium (11.33mg/100g) and magnesium were significantly higher in biscuit produced with 70% finger millet, 20%soybean, 10%carrot flour while potassium (12.66mg/100g) was significantly higher in biscuit produced with 45% finger millet, 45% soybean,10% carrot. Iron and zinc (3.11 vs1.96mg/100g) obtained in biscuits produced with 100% wheat were significantly higher than values of iron and zinc obtained for biscuits produced from the flour blends (2.53 – 2.78mg vs 1.63 – 1.81mg respectively).

Table 2: Minerals composition of biscuits produced with finger millet, soybean and carrot flour blends

Minerals (mg/100g)	Sample RA	Sample RB	Sample RC	Sample RD
Calcium	18.45^a±0.03	14.38^b±0.01	14.07^c±0.01	13.83^d±0.01
Sodium	9.61^d±0.01	11.33^a±0.02	11.18^b±0.01	11.02^c±0.01
Magnesium	7.21^d±0.01	10.86^a±0.02	10.63^b±0.01	10.52^c±0.02
Phosphorus	30.76^a±0.02	19.48^b±0.01	18.22^c±0.01	17.35^d±0.02
Potassium	4.82^d±0.02	11.11^c±0.01	12.02^b±0.02	12.66^a±0.02
Iron	3.11^a±0.01	2.53^d±0.02	2.62^c±0.01	2.78^b±0.01
Zinc	1.96^a±0.02	1.63^d±0.02	1.71^c±0.01	1.81^b±0.01

Values are mean ± standard deviation of 2 replicates. Mean within each column not followed by the same superscript are significantly different (P>0.05) from each other.
Keys:
RA = 100% wheat flour,
RB = 70% finger millet: 20% soybean: 10% carrot powder flour blends,
RC = 50% finger millet: 30% soybean: 20% carrot powder flour blends,
RD = 45% finger millet, 45% soybean: 10% carrot powder flour bends.

Vitamin composition of biscuits produced with finger millet, soybean and carrot flour blends

Vitamin composition of the samples is in Table 3. Biscuit produced with with70% finger millet, 20%soybean and 10% carrot (RB) had the highest value for vitamins B_1 (4.82mg), B_2 (8.21mg) and B_3 (2.97mg), vitamin C (3.27mg) and β-carotene (346µg). Biscuits produced with 50% finger millet: 30% soybean: 20% carrot flour blends had B_1 (4.75mg), B_2 (8.11mg), B_3 (2.92mg), vitamin C (3.15mg) and β-carotene (323.69µg). The values of B_1, B_2, B_3, Vitamin C and β-carotene for biscuits produced with 45% finger millet: 45% soybean: 10% carrot flour blends (RC) were 4.71mg, 8.05mg, 2.83mg, 2.93mg and 212.62µg respectively while biscuit produced from 100% wheat flour had the least values for vitamins B_1 (4.51mg), B_2 (7.81mg), B_3 (2.13mg), vitamin C (2.60mg) and β-carotene (26.7µg).

Table 3: Vitamin composition of biscuits produced with finger millet soybean and carrot flour blends

Vitamins (mg/100g)	Sample RA	Sample RB	Sample RC	Sample RD
Vitamin B_1	$4.51^d±0.01$	$4.82^a±0.02$	$4.75^b±0.01$	$4.71^c±0.01$
Vitamin B_2	$7.81^d±0.01$	$8.21^a±0.01$	$8.11^b±0.01$	$8.05^c±0.02$
Vitamin B_3	$2.13^d±0.01$	$2.97^a±0.01$	$2.92^b±0.01$	$2.83^c±0.02$
Vitamin C	$2.60^d±0.00$	$3.27^a±0.02$	$3.15^b±0.01$	$2.93^c±0.03$
β-Carotene (mcg/100g)	$26.7^d±0.03$	$346.45^a±0.03$	$323.68^b±0.06$	$312.62^c±0.02$

Values are mean ± standard deviation of 2 replicates. Mean within each column not followed by the same superscript are significantly different (P>0.05) from each other using Duncan multiple range test. Where: RA = 100% wheat flour, RB = 70% finger millet: 20% soybean: 10% carrot powder flour blends, RC = 50% finger millet: 30% soybean: 20% carrot powder flour blends, RD = 45% finger millet, 45% soybean: 10% carrot powder flour bends.

Sensory evaluation of biscuits produced with finger millet, soybean and carrot flour blends

Sensory evaluation of biscuits produced with finger millet, soybean and carrot flour blends are shown on Table 4. Mouth feel of biscuits produced with composite flours, 50% finger millet: 30% soybean: 20% carrot powder flour blends (6.35) and 45% finger millet, 45% soybean: 10% carrot powder flour bends (6.80) were comparable to value (7.50) obtained for biscuits produced with 100% wheat. Value (7.40) obtained for aroma for biscuits produced with 100% wheat was not significantly different from values (6.30 -6.45) obtained for the composite biscuits. Colour acceptability for 100% wheat biscuits (8.25) was significantly higher than values obtained for biscuits produced with finger millet; soybean and carrot flour blends (5.95-6.85). Values of texture and taste of biscuits produced from 100% wheat was (7.80,8.25) , 70% finger millet, 20% soybean and 10% carrot (RB) (6.55,6.60), 50% finger millet: 30% soybean: 20% carrot flour (6.35,6.45) and 45% finger millet: 45% soybean: 10% carrot flour blends (6.60, 6.30).

TABLE 4: Sensory evaluation of biscuits produced with finger millet, soybean and carrot flour blends

	Sample RA	Sample RB	Sample RC	Sample RD
Colour	$8.25^a±0.72$	$5.95^b±2.82$	$6.45^b±2.52$	$6.85^b±2.10$
Texture	$7.80^a±1.11$	$6.55^b±1.61$	$6.35^b±1.60$	$6.60^b±1.67$
Taste	$8.25^a±1.07$	$6.60^b±1.82$	$6.45^b±2.16$	$6.30^b±2.13$
Aroma	$7.40^a±1.31$	$6.30^a±1.59$	$6.40^a±1.81$	$6.45^a±1.67$
Mouth feel	$7.50^a±1.10$	$5.75^b±2.27$	$6.35^{ab}±1.90$	$6.80^{ab}±1.80$
General acceptability	$8.40^a±0.68$	$6.55^b±1.64$	$6.30^b±2.39$	$6.75^b±2.25$

Values are mean ± standard deviation of 2 replicates. Mean within each column not followed by the same superscript are significantly different (P>0.05) from each other using Duncan multiple range test. Where: RA = 100% wheat flour, RB = 70% finger millet: 20% soybean: 10% carrot powder flour blends, RC = 50% finger millet: 30% soybean: 20% carrot powder flour blends, RD = 45% finger millet, 45% soybean: 10% carrot powder flour bends.

DISCUSSION

Moisture was low in all the samples. Moisture in biscuits produced from composite flour was however significantly lower than that of biscuits produced with 100% wheat flour. Similar observation was made by Usman *et al*. (25) in biscuits produced from wheat flour and maize bran composite flour fortified with carrot extract. Lower moisture obtained in composite biscuits could be a function of their fiber contents. Fiber is known to play significant role in reducing water retaining capacity of bakery products (25).Moisture obtained in all the products was less than 10%. This implies that the products long shelf – life as moisture of ≤ 10% said to enhance packaging, general acceptability and shelf-life bakery products (26; 27).It is worthy to note that even though biscuits produced from composite flour had lower moisture values compared with biscuits produced from 100% wheat flour. This observation is in consonance with an earlier study which reported increase in moisture with increase in amount of soybean in bakery products (28).

Protein obtained in composites biscuits was about 35.3 to 41.9% higher than the protein content of wheat biscuit. Supplementation of finger-millet with soybean must have increased the protein content of the composite biscuits. Fatoumata *et al.* (29) also reported increase of protein with supplementation of millet with cowpea and bambara groundnut. Protein is an important nutrient needed for proper child development. Daily protein requirement of children within the 3 -7years, ranges between 13 – 26g/day

(30), this implies that 100g of the composite biscuits can supply about 70 – 74.4% of their daily protein needs while 100g of wheat biscuits will supply 54%. It was also observed that the composite biscuit had lower amount of carbohydrate but significantly high amounts of fiber, fat and ash than wheat biscuits. The fiber content was less than 3g while those of composite biscuits were greater than 3g. The high fiber found in the composite biscuits could be attributed to the effect finger-millet (31).

According to European Food Safety Authority (EFSA, 2010), a food can be referred to as a good "source of fiber" if it contains at least 3g/100g of dietary fiber, and "high in fiber" if it contains at least 6g/100g of dietary fiber. In that vein the composite biscuits can be classified as good source of fiber. Fiber is known for its role in increasing stool bulk by acting as a vehicle for faecal water (32). High fiber and low carbohydrate obtained in composite biscuits may aid digestion in the colon and reduce constipation are associated with products from refined grain flours (33). Carbohydrate content of composite biscuit was significantly higher than those of composite biscuits while energy was higher in composite biscuits. Higher energy found in composite relative to that of wheat biscuit could be a function of their fat and protein contents.

Results of minerals showed that biscuits produced from wheat flour were significantly higher in calcium, phosphorus, iron and zinc while those produced with composite were significantly higher in magnesium, potassium, and sodium. Taken together, phosphorus was the most predominant mineral followed be calcium in all products. Sodium was significantly higher in composite biscuits compared to values of sodium to potassium in wheat biscuits; it is however interesting to note that the ratio of K to Na (K/Na) in the composite biscuit was equal to 1 while the ratio in wheat biscuits was less than 1. The composite biscuits can be recommended to hypertensive patients as K/Na <1 plays significant role in salt sensitive individuals (34).

Iron and zinc obtained in composite biscuits were significantly lower than amounts found in wheat biscuits, this implies that supplementation of finger-millet flour with soybean and carrot flour did no not improve the zinc and iron values of the biscuits.

All the vitamins analysed were significantly higher in composite biscuits, with Sample RB (70% finger millet: 20% soybean: 10% carrot powder) having the higher vitamin values than the other composite biscuits. Vitamins are known for their roles in enhancing body metabolism. β- carotene is implicated in the enhancement of immune system, decreased risk of degenerative diseases such as cancers, cardiovascular disease, prevention of muscular degeneration and cataract formation (35), while the B-Vitamins play indispensable roles in the metabolism of carbohydrate, fats and protein in the body system (36).

The colour, texture and taste of wheat biscuits were more acceptable to those of composite biscuits. The dark and hard texture of the composite biscuits compared to those of wheat biscuits may have affected their acceptance. Hardness in biscuit produced from sorghum in part is attributed to lack of polar lipid in sorghum (37). Mouth feel of samples RC and RD were comparable to that of wheat biscuit while aroma was generally liked in all the samples.

CONCLUSION

Biscuits produced from composite flours had higher amounts of protein, fiber, lipid and vitamins values compared to biscuits produced from 100% wheat flour. Composite flour made from 70:20:10 flour blends is however recommended for biscuit production as it was richer in most nutrients compared to wheat and the other composite blends.

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