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Research Article
Chemical Evaluation of Biscuit Produced from Wheat, Yellow Maize and Beniseed Flour Blends

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Abstract

Background and Objective: Vitamin A is important for fighting infections, yet vitamin A deficiency is a widespread health challenge in sub-saharan Africa. This study was designed to investigate the beta-carotene and vitamins composition of biscuit produced from wheat, beniseed and yellow-maize composite flour. **Materials and Methods:** Maize and beniseed were processed into flour and used in substituting wheat flour at different proportion (100:0:0, 90:5:5, 80:15:5, 70:25:5 and 60:35:5) in baking biscuits using standardized recipe. Vitamins analysis of composite flour and biscuits were determined by standard laboratory methods. Sensory evaluation was carried out on biscuits using the multiple comparison test system. **Results:** The result showed that, there was significant difference ($p \leq 0.05$) in beta-carotene content in biscuits produced from 100% wheat flour biscuits produced from the composite flour. Beta-carotene (0.28 ± 0.05 to $19.57 \pm 0.19\ \mu g^{-1}$) content increased as the quantity of yellow maize flour increased. Results on Thiamin, riboflavin and vitamin E results also showed that there was significant difference between biscuits produced from 100% wheat flour and biscuits produced from composite flour. Sensory evaluation revealed that there was no significant difference ($p \geq 0.05$) in taste, texture and overall acceptability between biscuits produced from 100% wheat flour and biscuits produced from composite flour. **Conclusion:** The research findings suggested that the biscuits produced from composite flour can contribute about 50.33% RDA of vitamin A to preschool aged children due to its high level of beta-carotene. Hence, it can significantly reduce vitamin A deficiency and malnutrition.

Key words: Vitamin A, composite flour, yellow-maize, vitamin A deficiency, beniseed, beta-carotene

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Vitamin A is important for fighting infections, growth, bone development and overall health[1], yet vitamin A deficiency is a widespread health challenge in sub-saharan Africa[2]. Vitamin A deficiency is prevalent in Africa and afflicts millions of children, resulting in morbidity, blindness and even death[2]. Vitamin A is critical for vision as an essential component of rhodopsin, a protein that absorbs light in the retinal receptors and because it supports the normal differentiation and functioning of the conjunctiva membranes and cornea[3]. The World Health Organization has classified Nigeria among 34 countries in the world with serious problem of Vitamin A Deficiency (VAD) related nutritional blindness and xerophathalmia[4]. According to the world health organisation, VAD affects almost one in every three children in Nigeria. Therefore, there is need of using dietary intervention in combating the disease[4].

Globally, it has been estimated that at least 251 million children of preschool age are at risk of vitamin A deficiency (VAD) and 2.8 million are clinically affected[5]. In Africa 52 million children are at risk of VAD and an estimated 1.04 million of these have clinical signs of the deficiency[5]. Therefore; the use of pro vitamin A maize flour in substituting wheat in biscuits production will help in combating VAD. Every year, 250 000-500 000 children become partially or totally blind from VAD and two-thirds of these children die within a few months of going blind[5].

Biscuits constitute an important component of the diet[4], as such using biscuits as dietary intervention in combating vitamin A deficiency will produce good result, because it is highly consumed by people of all age group[6]. Research into the use of tropical crops has shown that biscuits and other pastries such as meat-pie, cookies, cake etc., could be produced from flours of locally available crops such as sweet potato, cassava, maize, rice, millet, sorghum etc. Biscuits are one of the most popular bakery products, widely consumed due to their ready-to-eat nature, good nutritional quality, low cost and longer shelf life and they are also rich in dietary fibre[6].

Maize and beniseed are abundantly produced in Nigeria and unconsumed maize and beniseed are lost due to lack of post-harvest storage facilities[7]. Using maize and beniseed flour in the production of biscuit will reduce the quantities of maize and beniseed that are lost due to poor storage facilities[7]. This will enhance the overall nutritional qualities of the biscuit, thereby reducing cases of protein energy malnutrition and vitamin A deficiency[8]. The use of wheat, beniseed and yellow maize composite flour in producing biscuit can help in reducing VAD because of the presence of beta carotene which is a precursor of vitamin A. Producing biscuit from yellow maize can help in reducing night blindness and other diseases that are associated with Vitamin A deficiencies.

Hence, the objective of this research was to determine the beta carotene, thiamin, riboflavin and to calculate vitamin A content of composite flour and biscuits produced from Wheat, Beniseed and yellow Maize Composite flour.

MATERIALS AND METHODS

Production of raw materials: The gathering of raw materials for the study started in April, 2017 and analysis on biscuit was carried out in December same year. Yellow maize (2009 TzE 1 D7 STR) used in this research work were collected from the International Institute for Tropical Agriculture (IITA), Ibadan. Wheat flour use in biscuit production was purchased from Dugbe market in Ibadan.

Beniseed was purchased from dugbe market in Ibadan. Preparation of biscuit samples were carried out in food processing laboratory of Nutrition and Dietetic Department of Federal University of Agriculture, Abeokuta.

Production of maize flour: The method described by Mbata *et al.*[9] was adopted in processing maize into flour as shown in Fig. 1. Maize flour were stored in a plastic container with lid and kept in a refrigerator from where samples were drawn for biscuit production.

Beniseed: The method described by Ayinde *et al.*[7] was adopted in processing beniseed into flour as shown in Fig. 2. The beniseed flour was stored in a plastic container with cover and kept in a refrigerator from where samples were drawn for analysis and biscuit production.

Production of biscuit: Wheat flour was substituted with yellow maize flour at 0, 5, 15, 25 and 35%, while beniseed flour was kept constant at 5%, the quantity of wheat and yellow maize flour was varied as presented in Table 1. The reason for keeping the quantity of beniseed flour constant was that beniseed flour was added to the composite blend in order to help increase the protein content and the overall nutritional qualities of the biscuit. Biscuits produced were milled into fine particles before they were analyzed for Mineral (Zn, K, Na and Cu), Vitamins (Vit B_1, Vit B_2 and Vitamin E) and beta-carotene content, while vitamin A was calculated based on the assumption that 12 µg of dietary beta-carotene can be converted to 1 µg of vitamin A.

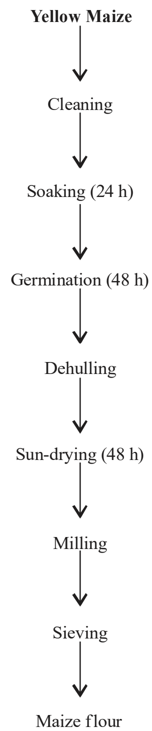

Fig. 1: Flow chart of yellow maize flour preparation[9]

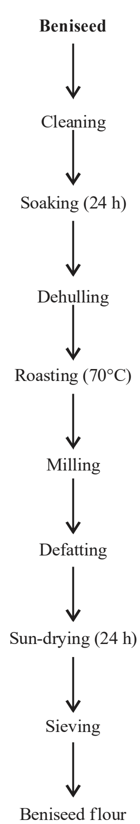

Fig 2: Flow chart of beniseed flour preparation[7]

Vitamin analysis: Thiamine content was determined using the method described by AOAC[10]. Five grams of each sample was homogenized in 5 mL normal ethanoic sodium hydroxide solution. The homogenate was filtered and made up to 100 mL with the extract solution. A 10 mL aliquot of the extract was dispensed into a flask and 10 mL potassium dichromate solution was added. The resultant solution was incubated for 15 min at room temperature (25±1°C). The absorption was read from spectrophotometer at 360 nm using a reagent blank to standardize the instrument at zero.

Riboflavin: Two grams of sample was placed in a conical flask and 50 mL of 0.2N HCl was added to the sample to boil it for 1 h and then cooled. The pH was adjusted to 6.0 using sodium hydroxide, 1 N HCl was added to the sample solution to lower the pH to 4.5. The solution was filtered into 100 mL measuring flask and made to volume with water.

Vitamin E content: About 1 g of sample was weighed into 100 mL flask, 10 mL of absolute alcohol and 20 mL M alcohol tetraoxosulphate VI acid were added. About 10 mL of the clear solution was pipetted into a test tube and heated in a water bath at 90°C for 3 min. This was allowed to cool. The absorbance was read in a spectrophotometer at 470 nm wavelength.

Beta-carotene: About 200 mg of sample were ground with a mortar and pestle in 8 mL of pre-warmed extraction medium containing absolute ethanol, 0.5% BHT. About 2 mL of hexane and acetone (2:1 ratio) was added. The extract was subjected to 10 min incubation under dark at room temperature (25-30°C), subjected to centrifugation at 5000 rpm for 10 min at 4°C and the supernatant transferred to a fresh tube. To the supernatant, an equal amount of 15% alkaline methanol KOH containing 0.5% BHT was added and incubated at 800°C for 15 min in a rotary water bath and chilled on ice for 5-10 min. To the saponified extract, 4 mL of distilled water and 3 mL of 2:1 PE: DE containing 0.5% BHT was added to achieve better phase separation. This was subjected to centrifugation at 5000 rpm for 10 min at 4°C, followed by transfer of the upper colored organic phase to a fresh tube. The left-over residue was again extracted twice with 4 mL of 2:1 PE: DE, the upper phases collected and pooled. Solvent evaporation was carried out in a vacuum drier at room temperature followed by the residual suspension in a mobile phase consisting of methanol: acetonitrile: chloroform (50:40:10) with 0.5% BHT (Fig. 1). The final carotenoid extract was filtered through a 0.45 µm PTFE syringe filter (Millipore®) into an HPLC sample vial.

Afterwards, vitamin A was calculated from beta-carotene based on the assumption that 12 µg of beta-carotene converts into 1 µg of retinol activity equivalents[11].

Mineral analysis: Mineral (potassium, zinc, copper and sodium) contents of the composite flour and biscuits samples were determined as described by AOAC[10]. The samples were ashed at 550°C. The ash was boiled with 10 mL of 20% hydrochloric acid in a beaker and then filtered into a 100 mL standard flask. This was made up to the mark with deionized water. The minerals were determined from the resulting solution. Sodium (Na) and potassium were determined using the standard flame emission photometer. The NaCl and KCl were used as standards.

Sensory evaluation: Sensory evaluation was carried out on biscuits with a team of 20 panelists adopting the multiple comparisons test system on a hedonic scale of nine. Panelists were instructed to evaluate coded samples for taste, texture and overall acceptability. Data from the sensory evaluations were subjected to a one-way analysis of variance (ANOVA) in order to determine the significant difference between means.

RESULTS

Results of vitamin composition of flour and biscuit: Results in Table 2 and 3 showed the results on beta-carotene, vitamin A, thiamin, riboflavin and vitamin E content of wheat, beniseed and maize composite flour and biscuits produced from them. The result showed that the values of beta-carotene in the biscuit ranged from 0.28±0.05 to 19.57±0.19 µg g^{-1} and 0.16±0.007 to 18.06±0.02 µg g^{-1} in flour. The values of calculated Vitamin A in the biscuit ranged from 0.02±0.05 to 1.63±0.19 µg g^{-1} and 0.01±0.007 to 1.51±0.02 µg g^{-1} in flour.

Results of mineral composition of flour and biscuit: The findings in Table 4 and 5 depicts the zinc, potassium, sodium and copper composition of wheat, beniseed and maize composite flour and biscuits produced from the flour blends. The results revealed that the value of zinc in the composite flour ranged from 0.009±0.03 to 0. 121±0.02 mg/100 g and 0.02±0.003 to 0.22±0.017 mg/100 g in biscuits. The value of potassium, sodium and copper were higher in biscuits produced from composite flour.

Sensory evaluation of wheat, beniseed and maize composite biscuit: Results on sensory evaluation for taste, texture and overall acceptability can be observed in Table 6. There was no significant difference between biscuits produced from 100% wheat flour and biscuits produced from other composite flour.

Table 1: Recipe used for biscuit production

	Samples (g)				
Ingredients	A	B	C	D	E
Wheat	100.0	90.0	80.0	70.0	60.0
Maize flour	0.0	5.0	15.0	25.0	35.0
Beniseed	0.0	5.0	5.0	5.0	5.0
Powdered sugar	30.0	30.0	30.0	30.0	30.0
Shortening	15.0	15.0	15.0	15.0	15.0
Milk powder	5.0	5.0	5.0	5.0	5.0
Soybean oil	10.0	10.0	10.0	10.0	10.0
Salt	0.5	0.5	0.5	0.5	0.5
Baking powder	1.5	1.5	1.5	1.5	1.5
Egg	30.0	30.0	30.0	30.0	30.0

A: 100% wheat, B: 90% wheat, beniseed 5 and 5% maize flour, C: 80% wheat, beniseed 5 and 15% maize flour, D: 70% wheat, beniseed 5 and 25% maize flour, E: 60% wheat, beniseed 5 and 35% maize flour

Table 2: Vitamin composition of wheat, beniseed and maize composite flour

Parameters	A	B	C	D	E
β-Carotene (µg g^{-1})	0.16±0.007^{a}	11.48±0.020^{b}	14.81±0.014^{c}	15.91±0.002^{c}	18.06±0.020^{d}
*Vit A (µg g^{-1})	0.01±0.007^{a}	0.96±0.020^{b}	1.23±0.014^{c}	1.33±0.002^{c}	1.51±0.020^{d}
Thiamin (mg/100 g)	0.23±0.007^{a}	0.23±0.002^{a}	0.24±0.021^{ab}	0.27±0.007^{c}	0.32±0.021^{d}
Riboflavin (mg/100 g)	0.16±0.003^{b}	0.15±0.027^{a}	0.14±0.040^{b}	0.11±0.011^{ab}	0.07±0.005^{b}
Vitamin E (mg/100 g)	0.04±0.003^{a}	0.35±0.00^{b}	0.34±0.054^{b}	0.33±0.033^{b}	0.31±0.037^{b}

Mean values bearing the same superscript within a row are not significantly different as $p \geq 0.05$, *Vitamin A was calculated at the ratio of 12:1 from beta-carotene. The retinol activity equivalent (RAE) is based on the assumption that 12 µg beta-carotene will be converted to 1µg retinol. A: 100% wheat, B: 90% wheat, beniseed 5 and 5% maize flour, C: 80% wheat, beniseed 5 and 15% maize flour, D: 70% wheat, beniseed 5 and 25% maize flour, E: 60% wheat, beniseed 5 and 35% maize flour

Table 3: Vitamin composition of wheat, beniseed and maize composite Biscuit

Parameters	A	B	C	D	E
β-Carotene (μg g^{-1})	0.28±0.050^{a}	12.75±0.058^{b}	15.10±0.049^{bc}	17.91±0.009^{d}	19.57±0.190^{e}
*Vit A (μg g^{-1})	0.02±0.050^{a}	1.06±0.058	1.26±0.049^{bc}	1.49±0.049^{d}	1.63±0.190^{e}
Thiamin (mg/100 g)	0.54±0.064^{a}	0.68±0.056^{c}	0.65±0.064^{bc}	0.61±0.003^{b}	0.60±0.029^{b}
Riboflavin (mg/100 g)	0.29±0.004^{b}	0.27±0.005^{a}	0.21±0.004^{ab}	0.21±0.008^{ab}	0.20±0.003^{c}
Vitamin E (mg/100 g)	0.30±0.004^{a}	0.56±0.010^{d}	0.54±0.041^{d}	0.45±0.003^{c}	0.38±0.013^{b}

Mean values bearing the same superscript within a row are not significantly different as p≥0.05, *Vitamin A was calculated at the ratio of 12:1 from beta-carotene. The retinol activity equivalent (RAE) is based on the assumption that 12 μg beta-carotene will be converted to 1μg retinol. A: 100% wheat, B: 90% wheat, beniseed 5 and 5% maize flour, C: 80% wheat, beniseed 5 and 15% maize flour, D: 70% wheat, beniseed 5 and 25% maize flour, E: 60% wheat, beniseed 5 and 35% maize flour

Table 4: Mineral component of wheat, beniseed and maize composite flour

	Mineral composition (mg/100 g)				
Parameters	A	B	C	D	E
Zinc	0.121±0.02^{b}	0.014±0.001^{a}	0.013±0.014^{a}	0.011±0^{a}	0.009±0.003^{a}
Potassium	15.940±0.106^{a}	20.160±0.091^{b}	23.090±0.134^{bc}	26.510±0.022^{c}	30.080±0.048^{d}
Sodium	7.110±0.163^{a}	8.490±0.438^{ab}	10.680±0.304^{b}	12.860±0.516^{c}	13.840±0.247^{c}
Copper	0.040±.046^{a}	0.080±0.065^{b}	0.060±0.049^{bc}	0.060±0.004^{c}	0.050±0.018^{c}

Mean values having the same superscript within a row are not significantly different as p≥0.05, A: 100% wheat, B: 90% wheat, beniseed 5 and 5% maize flour, C: 80% wheat, beniseed 5 and 15% maize flour, D: 70% wheat, beniseed 5 and 25% maize flour, E: 60% wheat, beniseed 5 and 35% maize flour

Table 5: Mineral component of wheat, beniseed and maize composite biscuit

	Mineral composition (mg/100 g)				
Parameters	A	B	C	D	E
Zinc	0.22±0.017^{b}	0.025±0.0^{a}	0.023±0.002^{a}	0.022±0.004^{a}	0.020±0.003^{a}
Potassium	29.43±0.078^{a}	30.440±0.63^{ab}	31.160±0.064^{b}	33.490±.035^{bc}	34.560±0.63^{c}
Sodium	9.60±0.00^{a}	18.430±0.275^{c}	18.380±0.12^{c}	17.110±0.035^{b}	18.070±0.269^{c}
Copper	0.09±0.064^{a}	0.180±0.028^{b}	0.090±0.028^{a}	0.090±0.035^{a}	0.100±0.021^{a}

Mean values bearing the same superscript (a, b, c and d) in the same row are not significantly different (p = 0.05), while mean values bearing different superscript in the same row are significantly different (p = 0.05), A: 100% wheat, B: 90% wheat, beniseed 5 and 5% maize flour, C: 80% wheat, beniseed 5 and 15% maize flour, D: 70% wheat, beniseed 5 and 25% maize flour, E: 60% wheat, beniseed 5 and 35% maize flour

Table 6: Sensory evaluation of wheat, beniseed and maize composite biscuits

Variables	Taste	Texture	Overall acceptability
A	7.3±1.60^{a}	6.4±1.07^{a}	7.8±0.63^{a}
B	6.5±1.79^{a}	4.1±1.37^{a}	7.0±0.82^{a}
C	7.2±1.48^{a}	6.6±0.97^{a}	7.6±0.84^{a}
D	6.8±1.69^{a}	6.6±0.84^{a}	7.2±0.92^{a}
E	6.9±1.66^{a}	7.3±0.95^{a}	7.4±0.07^{a}

Mean values having the same superscript within the same column are not significantly different (p≥0.05), A: 100% wheat , B: 90% wheat, beniseed 5 and 5% maize flour, C: 80% wheat, beniseed 5 and 15% maize flour, D: 70% wheat, beniseed 5 and 25% maize flour, E: 60% wheat, beniseed 5 and 35% maize flour

Contribution of biscuits to RDA of school age children: Results in Table 7 depicts the RDA for children of age 1-3 years and children of age 4-8 years, while the percentage contribution of the composite biscuits to the RDA of those children is presented in the last two columns of the table.

DISCUSSION

Vitamin A plays a key role in defense system of the body as it has the ability to fight infections. Moreover, it also impacts on growth, bone development and overall health[1]. The result on vitamins showed that beta-carotene and calculated vitamin A content increased as the quantity of yellow maize increased. This suggested that yellow maize contributed significant amount of beta carotene to the composite flour used in producing the biscuits, this finding consolidated the fact that yellow maize is high in beta-carotene content[12]. The consumption of 100 g of this biscuit will contribute about 50.33% RDA of vitamin A to children of age 1-3 years. The RDA of vitamin A for children of age 1-3 years is 300 mcg, while the RDA for school age children[13] is 400 mcg. The results showed that thiamin and vitamin E content in composite flours and biscuits produced from them were higher than 100% wheat flour and biscuits produced from it. But biscuit baked from 100% wheat flour had a higher content of Riboflavin than biscuit produced from wheat, beniseed and maize composite flour. The RDA for thiamin and riboflavin is 0.5 mg/day for children of age 1-3 years and 0.6 mg/day for children of age 4-8 years[13] as such the biscuits will contribute about 64 and 32% RDA for thiamin and riboflavin, respectively to a child of age 1-3 years. It was also observed that the addition of beniseed flour significantly increased the vitamin E content of composite biscuits and flour[14]. This implied that

Table 7: Contribution of the Biscuits to RDA of school age children

	RDA of children		*Contribution to RDA (%)	
Parameters	1-3 years	4-8 years	1-3 years	4-8 years
Zinc	3 mg	5 mg	0.67	0.40
Potassium	3 g	3.8 g	1.13	0.91
Sodium	1000 mg	1200 mg	1.88	1.56
Copper	340 mcg	440 mcg	52.94	40.91
Vitamin A	300 mcg	400 mcg	50.33	37.75
Thiamine	0.5 mg	0.6 mg	64.00	53.33
Riboflavin	0.5 mg	0.6 mg	32.00	23.33
Vitamin E	9 IU	10 IU	9.29	8.36

Sources: Dietary reference intakes tables and application from institute of medicine of the National Academy of Sciences[12]. *The last two columns showed the calculated percentage contribution of the composite biscuit to RDA of school age and pre-school age children

biscuit produced from wheat, beniseed and maize composite flour are able to increase vitamin E activities in children that consumed the product, thereby boosting their immune system and increasing the ability to fight infection[15]. The composite biscuit will contribute about 12% RDA of vitamin E to school age children. Beniseed consumption appears to increase plasma gamma-tocopherol and enhanced vitamin E activity which is believed to prevent cancer and heart disease[16]. There was significant difference ($p \leq 0.05$) in quantity of beta-carotene, calculated vitamin A, thiamin, riboflavin and vitamin E content in biscuits produced from 100% wheat flour and biscuit produced from composite flour. There was significant difference ($p \geq 0.05$) in the value of zinc, potassium, sodium and copper between biscuit produced from 100% wheat flour and biscuit produced from wheat, beniseed and maize composite flour. The composite flours contributed to the quantity of potassium, sodium and copper found in biscuits produced from wheat, yellow maize and beniseed flour[16]. The results showed that 100 g of biscuits produced from 60% wheat, 5% beniseed and 35% yellow maize flour (sample E) can contribute about 0.67% for zinc, 1.13% for potassium, 1.88% for sodium and 52.94% for copper of RDA for a child of age 1-3 years that will consume it. The contribution of the biscuit to the RDA of a child of age 4-8 years will be about 0.4% for zinc, 0.91% for potassium, 1.56% for sodium and 40.91% for copper. Sensory evaluation showed that there was no significant different ($p \geq 0.05$) in taste, texture and overall acceptability between any of the biscuits samples that were produced. Biscuit produced from 100% wheat flour score higher than biscuits produced from composite flour, although biscuit produced from composite flour were generally accepted by the entire panelist. This implied that biscuits with good sensory qualities can be produced from wheat, yellow maize and beniseed composite flour[17].

CONCLUSION

This study revealed that biscuit with high level of beta-carotene content was produced from wheat, beniseed and yellow maize composite flour. The biscuit has the potentials of reducing vitamin A deficiency among children that will consume the biscuit. The biscuit can contribute about 50.33% RDA of vitamin A in children, as a result of high beta-carotene content of the biscuit. Thus, the biscuit also have the potentials of reducing night blindness and other diseases that are vitamin A related among children.

SIGNIFICANCE STATEMENT

This study discovered that biscuits with high level of beta carotene content can be produced from wheat, beniseed and yellow maize composite flour. This biscuit will be able to reduce cases of vitamin A deficiency among children. This study will help researchers to uncover the critical area of using biscuit produced from yellow maize and beniseed in combating vitamin A deficiency that many researchers were not able to explore. Thus a new product that has potentials of combating vitamin A deficiency and other related diseases can be developed.

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