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Proximate composition of biscuits produced from wheat, yellow maize and sesame flours

Ighere DA[1], Dave-Omoregie AO[2], Abaku NS[3]
[1, 3] National Centre for Genetic Resources and Biotechnology (NACGRAB), Moor Plantation, Ibadan, Nigeria
[2] Nigeria Natural Medicine Development Agency, Nigeria

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Abstract

Background: Food-based nutrition intervention offers potentially sustainable approach to reducing multiple micronutrient deficiencies.
Objectives: This study was designed to evaluate the nutritional composition and sensory properties of biscuits produced from wheat, sesame and yellow-maize composite flour.
Materials and methods: Maize and sesame were processed into flour and mixed with wheat flour at different proportion (100:0:0, 90:5:5, 80:15:5, 70:25:5 and 60:35:5) in baking using standardized recipe. Proximate and mineral evaluation was carried out using standard laboratory methods. Multiple comparison test system was adopted during sensory evaluation.
Results: Protein, fats, crude fibre and ash contents in biscuits ranged from 5.02 to 6.49 g/100g, 13.17 to 19.75 g/100g, 1.17 to 1.88 g/100g and 2.14 to 2.66 g/100g respectively. There was significant difference ($p \leq 0.05$) in the quantity of protein, fats, moisture and carbohydrate contents in biscuits produced from 100 % wheat flour and biscuits produced from composite flours. Zinc was higher in biscuits produced from 100 % wheat flour compared to biscuits produced from composite flours. Iron, calcium, magnesium, and manganese contents were higher in biscuits produced from composite flour than biscuit produced from 100 % wheat flour. Sensory evaluation showed that there was no significant difference ($p \geq 0.05$) in taste, aroma, crunchiness and overall acceptability between 100% wheat biscuit and biscuits produced from composite flours.
Conclusion: Biscuits with acceptable nutritional value that can combat dietary deficiency were produced from wheat, beniseed and yellow maize composite flour.

Keywords: Biscuit, sesame, yellow-maize, dietary deficiency, proximate and micronutrients

Introduction

A nutrient is a component in foods that an organism uses to survive and grow. Macronutrients provide the bulk energy an organism's metabolic system needs to function while micronutrients provide the necessary cofactors for metabolism to be carried out [1]. Both types of nutrients can be acquired from the environment[1]. Micronutrients are used to build and repair tissues and to regulate body processes while macronutrients are converted to, and used for, energy. Methods of nutrient intake are different for plants and animals. Globally about 3.1 million children die of hunger every year, and about 66 million primary school aged children attend class hungry [2]. Micronutrient deficiencies affect more than two billion people of all ages in both developing and industrialized countries. They are the cause of some diseases, exacerbate others and are recognized as having an important impact on worldwide health. Micronutrient deficiencies are associated with 10% of all children's deaths [3], and are therefore of special concern to those involved with child welfare. Micronutrient deficiencies may be caused by long-term shortages of nutritious food or by infections such as intestinal worms [4].

Food-based nutrition intervention offers potentially sustainable approach to reducing multiple micronutrient deficiencies. Using sesame and yellow maize composite flour in producing biscuits will help in combating micronutrient deficiency due to the high nutrient content of sesame and high beta carotene content of yellow maize. Biscuits have very good potentials of being used as food-based nutrition intervention to reach a wide range of affected individuals, because it is a common item of consumption among all classes of people. With tea or coffee, biscuit makes a tasty nutritious snack. Biscuit is highly nutritious, easy to digest and can be preserved for a long time [5]. Biscuits have been suggested as a better use of composite flour than bread due to their ready to eat form, wide consumption, relatively long shelf life and good eating quality [6].

Biscuits are important cereal foods consumed in all over the world, they are ready to eat, convenient and inexpensive food products [7]. They are snacks produced from unpalatable dough that is transformed into appetizing products through the application of heat in the oven [8]. Most of these foods are however poor sources of protein and such contribute to poor nutritional quality [9, 10]. Being a ready to eat convenient food product, it is important to be fortified with vitamins and minerals [11].

Yellow maize and sesame are highly produced around the globe; therefore, using yellow maize and sesame flour in substituting wheat flour in biscuit production will help in reducing the cost of the product and at the same time increase the nutritional value of the biscuits. Sesame will increase the protein, fat and mineral content of the biscuit and it will also help in reducing cases of multiple micronutrient deficiency and protein energy malnutrition (PEM) among those that will consume it. The cost of production of biscuits is high in countries where wheat is not grown and it is imported for baking.

This research was designed to determine the proximate, mineral and sensory properties of biscuits produced from wheat, sesame and yellow maize composite flour.

Materials and Methods

Production of raw Materials

Raw materials gathering started in April 2017 and production and analysis on biscuit was carried out December same year. Yellow maize (2009 TzE 1 D7 STR) was collected from the International Institute for Tropical Agriculture (IITA), Ibadan. Sesame and wheat flour were purchased from Dugbe market in Ibadan, Nigeria. Preparation of biscuit samples were carried out in food processing laboratory of Nutrition and Dietetic Department of Federal University of Agriculture, Abeokuta, Nigeria.

a) Production of maize flour

The method described by Mbata *et al*, as shown in the flow chart below was adopted in processing maize into flour [12]. Maize flour was stored in a plastic container with lid, and kept in a refrigerator from where samples were drawn for biscuit production.

Yellow Maize
↓
Cleaning
↓
Soaking (24h)
↓
Germination (48h)
↓
Dehulling
↓
Sun- drying (48h)
↓
Milling
↓
Sieving
↓
Maize flour

Fig 1: Flow chart of yellow maize flour preparation [11] (Mbata 2009)

b) Sesame flour

The method described by Ayinde *et al.*, 2012 was adopted in preparing sesame flour [13]. 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.

Sesame seed
↓
Cleaning
↓
Soaking (24 h)
↓
Dehulling
↓
Roasting (70 ^{o}c)
↓
Milling
↓
Defatting
↓
Sun drying (24 h)
↓
Sieving
↓
Sesame flour

Fig 2: Flow chart of sesame flour preparation (Ayinde *et al.,* 2012)

c) Biscuits

The recipes as described by Khaliduzzaman in 2010 were used in biscuit production as shown in table 1 [14].

Table 1: Recipe used for biscuit production

Ingredients	Samples (g)				
	A	B	C	D	E
Wheat	100	90	80	70	60
Maize flour	0	5	15	25	35
sesame	0	5	5	5	5
Powdered sugar	30	30	30	30	30
Shortening	15	15	15	15	15
Milk powder	5	5	5	5	5
Soybean oil	10	10	10	10	10
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	30	30	30	30

Proximate Analysis

The method as describe by AOAC in 2010 was adopted in carrying out proximate analysis [15].

Moisture; 5 g of sample was taken and put into a pre-weighed drying dish. Dish and contents was weighed and dry to constant weight. After drying, dish was placed in desiccators to cool. Sample was reweighed, and loss in weight was reported as moisture.

$$\% \text{ Moisture} = \frac{W_2 - W_3}{W_2 - W_1} \text{ X } 100$$

Ash; 2 g of finely grounded dry sample was weighed into a porcelain crucible, char sample on a Bunsen flame. Transfer sample into a preheated oven and heat sample until light gray ash results. Cool in desiccators and reweigh.
Calculate ash content as;

$$\% \text{ Ash} = \frac{\text{Weight of Ash}}{\text{Weight of original food}} \text{ X } 100$$

Crude fibre; 2 g of sample was weighed, boiled for 30 minute with 200 ml of water containing 1.25 g of H_2SO_4 per 100 ml of solution. Residue was filtered and washed with boiled water. Residue was boiled for 30min in a beaker with 200 ml of water containing 1.25 g of NaOH per 100 ml. The final residue was filtered and dried in an oven and weighed, then incinerated, the sample was cooled and the weight of the sample was taken after cooling.
% Crude fibre = the loss in weigh after incineration multiply by 100.
Fat; samples were mixed with a mixture of methanol and chloroform in such proportions to give a single phase miscible with water. Extra chloroform was added to give a separation of the phases, the solvents was separated by centrifuging. Chloroform layer containing dissolved fat was removed. The fat residue left behind was weighed.

$$\% \text{ Fat} = \frac{\text{Weight of Fat}}{\text{Weight of sample}} \text{ X } 100$$

Protein; 2 g of sample was weighed into a Kjeldahl flask, and 5 g of anhydrous sodium sulphate was added, then 1 g of copper sulphate and a speck of selenium was added. Then 25 ml of conc sulphuric acid was added to the mixture. It was heated in a fume cupboard till solution assumes a green colour. It was cooled and any black particles showing at the mouth of the flask were washed down with distilled water. It was re-heated gently at first until the green colour disappears. After cooling, the digest was transferred into 250 ml volumetric flask and made up to the mark with distilled water. Nitrogen was estimated by titration of ammonium borate that is produced with standard HCl

Mineral analysis

The method as describe by AOAC in 2010 was adopted in carrying out mineral (zinc, iron, magnesium, calcium and manganese) analysis [15]. The samples were ashed at 550 ºC and the ash was boiled with 10ml 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. NaCl and KCl were used as standards.

Sensory evaluation

Sensory evaluation of the biscuits samples were carried out with a team of ten (20) panelists. The hedonic scale of nine was used, and the panelists were instructed to evaluate the coded samples for Taste, Aroma, Crunchiness and Overall acceptability with a reference sample A. Each sensory attribute was carried out, with panelist adopting the multiple comparison test system. Data obtained from chemical analysis and the panelist's evaluation on Taste, Aroma, Hardness, Crunchiness and Overall acceptability were subjected to a one-way analysis of variance (ANOVA, SPSS version 17, 2008) in order to determine the significant difference between mean of the various parameters.

Results

Proximate composition

Results of proximate composition of the wheat, sesame and yellow-maize composite flour and biscuits are shown in table 2 and 3. The results showed that the value of moisture content in composite flour ranged from 14.18±0.55 to 15.70±0.06 g/100g. The value of moisture content in biscuits ranged between 11.50±0.04 and 13.35±0.19 g/100g. Ash content in composite flour ranged between 2.05±0.06 and 2.31±0.01 g/100g. The ash content of biscuit ranged from 2.41±0.04 to 2.66±0.03 g/100g. The concentration of fats in the composite flour ranged from 12.09±0.08 to 15.41±0.13 g/100g, while the concentration of fats in the biscuit produced from the same composite flour ranged from 13.17 ±0.04 to 19.75 ±0.11 g/100g. The value of crude fibre in the composite flour ranged from 0.35 ±0.02 to 0.98 ±0.02 g/100g; while that of biscuit ranged between 1.17 ±0.04 to 1.88 ±0.07 g/100g. The value of protein in composite flour ranged from 3.90 ±0.02 to 5.09 ±0.07 g/100g; while the value of protein in biscuit ranged from 5.02 ±0.01 to 6.49 ±0.01 g/100g. Carbohydrate value in composite flour ranged from 61.27 ±0.35 to 67.43 ±0.37 g/100g; while carbohydrate value in biscuit ranged from 56.64 ±0.23 to 65.90 ±0.08 g/100g.

Table 2: Proximate composition of wheat, sesame and maize composite flour

Nutrient content (g/100g)					
	A	**B**	**C**	**D**	**E**
Protein	3.90± 0.02^{a}	5.09± 0.07^{b}	4.62± 0.04^{b}	3.93± 0.02^{a}	3.84± 0.04^{a}
Fat	12.09± 0.08^{a}	15.41± 0.13^{c}	14.22± 0.08^{b}	13.56± 0.38^{ab}	12.58± 0.02^{a}
Ash	2.05± 0.06^{a}	2.12± 0.09^{a}	2.17± 0.01^{a}	2.21± 0.04^{a}	2.31± 0.01^{a}
Crude fibre	0.35± 0.02^{a}	0.98± 0.02^{a}	0.74± 0.02^{a}	0.89± 0.03^{a}	0.57± 0.02^{a}
Moisture	14.18± 0.55^{a}	15.70± 0.06^{b}	15.08± 0.44^{b}	14.74± 0.15^{ab}	14.29±0.57^{a}
Total Carbohydrate	67.43± 0.37^{c}	60.70± 0.33^{a}	61.17± 0.35^{ab}	64.67± 0.56^{b}	66.41± 0.57^{c}

Mean values having the same superscript within a row are not significantly different as ($p \geq 0.05$)
A = 100 % wheat
B = 90 % wheat, sesame 5 % and 5 % maize flour
C = 80 % wheat, sesame 5 % and 15 % maize flour
D = 70 % wheat, sesame 5 % and 25 % maize flour
E = 60 % wheat, sesame 5 % and 35 % maize flour

Table 3: Proximate composition of wheat, sesame and maize composite biscuit

Nutrient content (g/100g)					
	A	**B**	**C**	**D**	**E**
Protein	5.02± 0.01[a]	6.49± 0.01[b]	5.88± 0.09[ab]	5.84± 0.01[b]	5.78± 0.063[ab]
Fat	13.17± 0.04[a]	19.75± 0.11[b]	18.68± 0.02[b]	14.49± 0.69[a]	13.91± 0.67[a]
Ash	2.41± 0.04[b]	2.42± 0.0[a]	2.57± 0.03[ab]	2.66± 0.03[a]	2.48± 0.04[ab]
Crude fibre	1.17± 0.04[ab]	1.35± 0.53[ab]	1.68± 0.02[ab]	1.72± 0.02[b]	1.88± 0.07[b]
Moisture	11.60± 0.04[a]	13.35± 0.19[bc]	13.05± 0.04[bc]	11.50± 0.19[a]	12.52± 0.62[ab]
Total Carbohydrate	65.90±0.078[bc]	56.64±0.226[a]	60.14±0.014[a]	61.79±0.530[b]	61.43±0.261[b]

Mean values having the same superscript within a row are not significantly different as ($p \geq 0.05$)
A = 100 % wheat
B = 90 % wheat, sesame 5 % and 5 % maize flour
C = 80 % wheat, sesame 5 % and 15 % maize flour
D = 70 % wheat, sesame 5 % and 25 % maize flour
E = 60 % wheat, sesame 5 % and 35 % maize flour

4.3 Mineral composition

Table 4 and 5 showed the mineral composition of wheat, sesame and maize composite flour and that of biscuits produced from the flour blends. The results reveal that the value of zinc in the composite flour ranged between 0.009 ±0.03 and 0.0121 ±0.02 mg/100g; while that of the biscuit ranged from 0.02 ±0.003 to 0.22 ±0.017 mg/100g. The results showed that, there was no significant difference in the quantity of iron, magnesium, calcium, and copper found in biscuits produced from 100 % wheat flour and biscuits produced from wheat, maize and sesame composite flour. But there was significant difference in the quantity of potassium, sodium, manganese and zinc found in biscuits produced from 100 % wheat flour and biscuits produced from wheat, maize and sesame composite flour.

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

Mineral composition (mg/100g)					
	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]
Iron	1.70±0.11[ab]	1.89±0.01[ab]	1.88±0.141[ab]	1.72±0[a]	1.71±0.14[a]
Magnesium	1.11±0.04[a]	1.14±0.064[a]	1.25±0.071[a]	1.31±0.050[a]	1.39±0.04[a]
Calcium	29.63± 0.113[a]	32.93±0.134[a]	32.85±0.021[a]	32.80±0.078[a]	32.69±0.40[a]
Manganese	0.17±0.042[a]	0.30±0.163[b]	0.27±0.007[b]	0.24±0.042[b]	0.20±0.007[b]

Mean values having the same superscript within a row are not significantly different as ($p \geq 0.05$)
A = 100 % wheat
B = 90 % wheat, sesame 5 % and 5 % maize flour
C = 80 % wheat, sesame 5 % and 15 % maize flour
D = 70 % wheat, sesame 5 % and 25 % maize flour
E = 60 % wheat, sesame 5 % and 35 % maize flour

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

Mineral composition (mg/100g)					
	A	B	C	D	E
Zinc	0.22±0.017[b]	0.025±0[a]	0.023±0.002[a]	0.022±0.004[a]	0.020±0.003[a]
Iron	2.00±0.035[a]	2.22±0.007[ab]	2.19±0.014[ab]	2.14±0.403[a]	2.12±0.014[a]
Magnesium	1.39±0.014[a]	1.57±0.078[ab]	1.53±0.057[a]	1.52±0.028[a]	1.49±0.007[a]
Calcium	32.30±0.007[a]	35.40±0.014[ab]	35.44±0.028[ab]	35.47±0.049[ab]	35.52±0.049[ab]
Manganese	1.16±0.063[a]	1.17±0.021[a]	1.19±0.014[ab]	1.27±0.071[b]	1.60±0.049[c]

Mean values having the same superscript within a row are not significantly different as ($p \geq 0.05$)
A = 100 % wheat
B = 90 % wheat, sesame 5 % and 5 % maize flour
C = 80 % wheat, sesame 5 % and 15 % maize flour
D = 70 % wheat, sesame 5 % and 25 % maize flour
E = 60 % wheat, sesame 5 % and 35 % maize flour

4.4 Sensory evaluation results of wheat, beniseed and maize composite biscuit

Table 6 showed the results for mean value of data obtained from panelist evaluation of the biscuits that were produced. The mean values of the results of evaluation by panelist were analyzed statistically to determine the significant difference between the five biscuits that were produced. The results reveal that biscuits produced from 100 % wheat flour are not significantly different from biscuits produced from other composite flour of different ratios. Parameters that were evaluated include Taste, Aroma, Crunchiness and Overall Acceptability.

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

	Taste	Aroma	Crunchiness	Overall Acceptability
A	7.3±1.60 ^{a}	7.3±1.16 ^{a}	6.5±0.85 ^{a}	7.8±0.63 ^{a}
B	6.5±1.79 ^{a}	6.8±2.00 ^{a}	6.2±0.97 ^{a}	7.0±0.82 ^{a}
C	7.2±1.48 ^{a}	7.5±1.18 ^{a}	6.7±0.95 ^{a}	7.6±0.84 ^{a}
D	6.8±1.69 ^{a}	7.5±1.08 ^{a}	6.8±0.92 ^{a}	7.2±0.92 ^{a}
E	6.9±1.66 ^{a}	7.1±1.67 ^{a}	7.0±0.67 ^{a}	7.4±0.07 ^{a}

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

Table 7 showed the RDA of the nutrients that were evaluated for children of age 1 to 3 years, and also the percentage contribution of the biscuit to the RDA of those children. The results showed that biscuit produced from 90 % wheat, 5% beniseed and 5% maize flour will contribute about 46.36 % and 32.35 % RDA for children of age 1 to 3 years and children of age 4 to 8 years respectively. While biscuit produced from 60 % wheat, 5 % beniseed and 35 % maize flour will contribute about 0.67 % for zinc, 34.86 % for iron, 2.36 % for magnesium, 5.07 % for calcium and 133.33 % for manganese.

Table 7: RDA of school age children and possible percentage contribution of the composite biscuit

RDA		*Contribution to RDA (%)		
	1-3yrs	**4-8yrs**	**1-3yrs**	**4-8yrs**
Zinc	3mg	5mg	0.67	0.4
Iron	7mg	10mg	34.86	24.4
Magnesium	80mg	130mg	2.36	1.46
Calcium	700mg	1000mg	5.07	3.6
Manganese	1.2 mg	1.5mg	133.33	106.67
Protein	14g/day (1.08g/kg)	20g/day (0.91g/kg)	46.36	32.35

***Sources*:** Dietary Reference Intakes Tables and Application from Institute of Medicine of the National Academy of Sciences, November 30 2010. *The last two columns showed the calculated percentage contribution of the composite biscuit to RDA of school age and pre-school age children.

5. Discussion

Biscuits produced from wheat, beniseed and yellow maize composite flour (sample B, C, D, and E) have higher values of protein, fats, ash and crude fibre content than biscuit produced from 100 % wheat flour (sample A); the same thing was observed in the wheat, sesame and maize flour evaluation. There was significant difference ($p \leq 0.05$) in quantity of protein, fats, moisture and carbohydrate content between biscuit produced from 100 % wheat flour and biscuits produced from wheat, beniseed and maize composite flour. The inclusion of beniseed flour in the recipe increased the protein, fats and moisture contents of the biscuit and flour, because sesame is known to contain high level of protein and fats [16]. The RDA of protein for children of age 1 to 3 years is 1.08 g/kg body weight; while the RDA for children of age 4 to 8 years is 0.91 g/kg body weight [17]. Therefore, the consumption of 100 g of this biscuit will provide about 32.35 to 46.36 % RDA of children that are consuming the product, thereby reducing cases of protein energy malnutrition in pre-school and school age children. This result is in agreement with the work of Olagunju and Ifesan in 2013; which stated that beniseed is high in protein and oil concentration [18].

The results revealed that there was no significant difference in ash and crude fibre content between ash content of biscuits produced from 100 % wheat flour and biscuits produced from wheat, sesame composite flour. Although biscuit produced from composite flour has higher value of ash and crude fiber, this may be as a result of influence of beniseed flour on the mineral level of composite blend [20]. This indicated that incorporation of beniseed may enhance the amount of mineral intake in the food product [21], and as such would contribute appreciable dietary amounts of mineral. Sesame has higher level of crude fibre than wheat flour [20, 22]; this was reflected in the quantity of crude fibre that was recorded in the biscuits produced from wheat, beniseed and maize composite flour. The crude fibre values recorded from all the biscuit samples are within the recommended level of ≤ 6 g/100g [23].

Biscuits produced from 100 % wheat flour were significantly different in moisture content from biscuits produced from different proportion of wheat, beniseed and maize composite flour; this can be attributed to different storage condition and packaging material. Eriksson *et al.*, stated that low moisture content is essential for storage of flour to prevent growth of microorganisms, fermentation and caking [24]. The increase in moisture content in composite flours could be due to increased protein level from beniseed addition; because proteins particularly from cereals have been noted to have high affinity for moisture and would absorb increasing amount of moisture if available [25, 26].

Carbohydrate values recorded showed that 100 % wheat flour and biscuit produced from it has the highest carbohydrate value. The increase in protein, ash and crude fiber contents of biscuit produced from wheat, beniseed and maize composite flour could be as a result of beniseed flour addition, because previous studies reported that beniseed flour contains higher amounts of protein, ash and crude fiber than wheat flour [27].

The mineral content (Calcium, iron, Magnesium and Manganese) of the biscuits produced from 100 % wheat flour were lower than the mineral contents of biscuit that were produced from wheat, beniseed and maize composite flour; the same observation was noticed from the result of the flour analysis. Christine *et al.*, also had similar results in their work on nutritional and organoleptic properties of wheat and beniseed composite flour baked food [22]. This result supported the fact that beniseed which is one of the composite flour used in producing the biscuit, is packed with a lot nutrient, hence there is an increases in mineral content of biscuit produced from wheat, beniseed and maize composite flour than biscuit produced from 100 % wheat flour.

Results of sensory evaluation showed that there was no significant different ($p \geq 0.05$) in Taste, Aroma, Crunchiness and Overall Acceptability between biscuits produced from 100% wheat flour and biscuits produced from wheat, beniseed and yellow maize composite flour. This work is in agreement with that of Afolabi *et al*.; on the acceptability and chemical composition of bread from beniseed [28]. As such biscuit of acceptable sensory properties were produced from wheat, beniseed and maize composite flour.

Conclusion

Biscuits produced from composite flour of wheat, beniseed and yellow maize measure favourably well in proximate and sensory evaluation with biscuits produced from 100 % wheat flour. The composite biscuits possessed higher protein content than biscuits produced from 100 % wheat flour. Therefore; biscuit produced from composite flour have added functionality which gives the biscuit the potentials that will help it to reduce cases of malnutrition and other diseases that are plaguing sub-Sahara Africa.

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