Proximate, Micronutrient Composition, Physical and Sensory properties of Cookies Produced from Wheat, Sweet Detar and Moringa Leaf Flour Blends

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Abstract
Cookies were produced from fermented sweet detar, Moringa leaf and wheat composite flours. The proximate composition of the cookies were determined as well as the physical properties, micronutrient composition (mineral and vitamins) and sensory attributes of the cookies. The result showed that moisture content varied from 10.89 – 13.10%, protein content ranged from 6.21 – 8.43%, ash content varied from 1.96 to 3.83%, fat content ranged from 19.50 – 23.33%, fibre content ranged from 2.05 to 3.96%, and carbohydrate content decreased from 57.94 – 47.59%. The beta-carotene and vitamin C content ranged from 0.00mg/100g – 119.17mg/100g and 2.00mg/100g – 19.38mg/100g. Calcium, Iron, Zinc and Potassium contents ranged from 21.26–86.12mg/100g, 2.10–2.80mg/100g, 0.91–0.99mg/100g and 89.46–234.29mg/100g. The values of the diameter, weight and thickness of the cookies ranged from 4.46-4.52cm, 14.40-14.95g and 0.84 – 0.99cm. The sensory scores for appearance (4.20–8.26), aroma (4.46–7.60), crispness (4.86–7.33), taste (4.40–7.60), texture (5.33–7.46) and general acceptability (4.66 – 8.13) were recorded. Based on the parameters analyzed, fermented sweet detar, moringa leaf and wheat composite flours could be used in the production of nutritious and acceptable cookies.

Introduction
Cookies are baked product that are increasingly becoming very important snack foods due to their taste, crispiness, digestibility, ready to eat, convenience and relatively stable shelf life. Cookies have lower moisture content and softer chewer texture than biscuits. Cookies are small, flat dessert treats, commonly made in variety of style using various ingredients such as; wheat, flour, sugar, chocolates, peanut butter/cooking oil, nuts or dried
fruits and eggs. Generally cookies comprises of; 18.5% fat, 78.23% carbohydrates, 1.0% ash, 7.1% protein and 0.85% salt. Wheat is the major ingredient used for the production of cookies but it is low in lysine and certain amino acids which are normally supplemented by the use of legumes to improve the protein quality. Many researchers have produced composite cookies with different crops excluding the use of sweet detar and Moringa oleifera leaf flour blends.

Composite flour is a mixture of flour/starches and other ingredients meant to replace wheat flour in total or partially in pastry or baked products. The use of composite flour is very desirable in developing countries in order to reduce the importation of wheat and promote the use of local crops. Legumes flours usually contain higher protein and calories when combined with other crops.

Wheat (Triticum spp.) is one of the most important cereal for human consumption in variety of forms including; flours, breads, cookies, cakes, biscuits, macaroni, spaghetti, pasta, noodles and various alcoholic drinks. In Nigeria, wheat is not grown due to climatic reasons therefore it is usually imported using huge sums of money. Therefore the use of composite flour is promoted in Nigeria to decrease wheat importation and encourage production of protein enriched crops and products.

Moringa oleifera belongs to the genus Moringa and is one of the commonest specie known. Moringa oleifera is known by various names in different locations all over the world. Some of its names are; mullungay, drumstick, West Indian ben. In Nigeria, Moringa oleifera has many local names such as; Jeghel- agede (Tiv), Zogale (Hausa), Okwe Oyibo (Ibo), Ewe ile (Yoruba).

The leaves, foliage, seeds and every part of the Moringa plant is nutrient dense and of food value to both animals and human beings.

Sweet detar (Detarium microcarpum) is an under-utilized legume plant that belongs to the family Fabaceae. It has been reported that the seeds contain about 69.98% carbohydrate, 13.12% protein, 0.5% crude fibre, 10% crude fat (predominantly linoleic acid), 5.0% moisture and 1.4% ash. In Nigeria, it is known by different names, by Igbo's as ‘ofor’, Yoruba's as ‘ogbogbo’ and Hausa's as ‘taura’. ‘ofor’ can be used as thickeners, stabilizers or processed into condiments or fermented food products. The Gum from D. microcarpum can also be used to increase water absorption and mixing tolerance index of dough. It was also documented that the addition of this gum to fruit products also improved their stability during storage.

Reports by Researchers have shown that sweet detar offers protection against syphilis, dysentery, bronchitis, leprosy, sore throat, malaria and meningitis. It also contains essential minerals like sodium (438.5mg), potassium (593.7mg), magnesium (20.5mg), calcium (90mg), sulphur (37.24mg), phosphorus (204.5mg) and iron (100mg) and vitamin C (3.2mg). The legume however, contains some anti-nutrients such as saponins, phytates and cyanide. These compounds tend to lower protein digestibility and bioavailability of the nutrients, hence the need for fermentation of the legumes. Fermentation would decrease the amount of anti-nutritional factors, improve nutritional value, digestibility of protein, increase bioavailability of the minerals and enhance flavour and colour.

The aim of this work is to produce and evaluate the quality of cookies from the composite flours of wheat, sweet detar and Moringa oleifera leaf.

Materials and Methods
Raw materials collection
The wheat flour, sweet detar seeds, and other ingredients were purchased from local markets in Makurdi town of Benue state Nigeria. Moringa oleifera leaves were plucked from the farm in University of Agriculture Makurdi. The crops were identified in the Biological Sciences Department of University of Agriculture Makurdi.

Sample Preparation
Fermented Sweet detar Flour
The method outlined by Igbabul et al. was adopted for the preparation of fermented sweet detar flour. The sweet detar seeds were cleaned and the extraneous materials, stones and sticks were sorted out and toasted for 15 minutes. The seed coats were removed using a hammer mill, washed and soaked in tepid water to ferment for 72 hours. The seeds
were then sun dried, ground into flour, sieved and packaged in an air tight container. The process for the production of fermented sweet detar flour is shown in Fig. 1.

**Moringa Leaf Flour**
The *moringa* leaf flour was prepared by the method outlined by Olushola. The leaves were plucked from the tree, washed in potable water and dried under shade for ten days. Milling of the dried leaves was carried out using a kitchen blender. It was then packed in air tight polythene bags and stored at ambient temperature of 32°C. The production process is shown in Fig. 2.

**Formulation of Blends (%) for Composite Flour**
The wheat, fermented sweet detar and *moringa* leaf flours were mixed in Philip blender (HR2811 model) at full speed for 5 minutes to obtain five different samples labeled Samples A, B, C, D and E as shown in Table 1.

**The ingredient used in the baking of cookies**
The type and quantities of ingredients used in the baking of composite cookies from fermented sweet detar, *moringa* leaf and wheat is shown in Table 2.

**Proximate Composition of the Cookies**
The analysis of the proximate composition of the cookies was carried out using the Association of Official Analytical Chemists (AOAC)23 method. The parameters analyzed include; ash, moisture, fat, crude fibre and protein content. Carbohydrate was calculated by difference and the energy content by a method described by Egounlety.

**Physical Properties of the Cookies**
The physical properties were determined by the American Association of Cereal Chemists (AACC) methods. The electronic weighing balance was used to take the weights, the vernier caliper was used to measure the diameter (D) and thickness (T) of the cookies.

The Spread Factor (SF) was calculated by dividing the diameter over the thickness and multiplying with a correction factor of 10.

**Analysis of Micronutrients**
The Atomic Absorption Spectrophotometer (AA 800 Perkin-Elmer Germany) was used to analyze the micronutrients content of the cookies by the AOAC method.

Beta-carotene (pro-vitamin A) and vitamin C were analyzed. The minerals (calcium, iron, zinc, potassium) of the cookies were also determined using the same method.

**Sensory Evaluation**
The sensory evaluation was carried out by a panel of Judges comprising of fifteen persons. These persons were familiar with the product and some were students and others were staff of the Department of Food Science and Technology. The samples...
of the cookies were coded and analyzed based on crispness, appearance, aroma, taste, texture and general acceptability. The cookies were rated 1 (extremely dislike) to 9 (like extremely) Iwe 26, Ikehoronye and Ngoddy.27

**Statistical Analysis**

The data obtained from the sensory evaluation were subjected to Analysis of Variance (ANOVA) as described by Iwe.26 The Least Significant Difference (LSD) was used to determine the difference between the samples at 5% level of probability (P<0.05).

**Result and Discussion**

**Proximate Composition of the Cookies**

The result of the proximate composition of the cookies is shown in Table 1. The moisture content varied from 10.89 – 13.10%, sample B had the lowest value of 10.89% while sample E had the highest value of 13.10%. The implication is that the shelf life of the composite cookies from sample B will be more stable compared to sample E (60% Wheat flour, 20% Fermented Sweet detar flour, 20% *moringa* Leaf flour. This result is in line with that reported by Olapade and Adeyemo.28 From the result, the moisture content of the cookies varied significantly (p<0.05) except sample B and C that were not significantly (P>0.05) different.

The protein content ranged from 6.21 – 8.43%. Sample E recorded the highest value of 8.43% while sample A had the lowest value (6.21%). The result obtained showed significant differences (p<0.05) among the samples except for sample D and E which are not significantly different. This could be attributed to the increased in microbial mass of the sweet detar seeds during fermentation causing extensive hydrolysis of the protein molecules to amino acids and other simple peptides, making it a high quality protein that can substitute animal protein in diet.29

The fat content of the cookies varied from 19.50 to 23.42% with the control sample A having the lowest value. The increase was significantly different (P<0.05). This could be contributions of fats from sweet detar, *moringa* leaf flours and the fat that was used in baking the cookies.

The ash content of the cookies varied significantly (p<0.05) from sample A – E. Sample A, the control sample recorded the lowest value and increased from 1.96 to 3.83% and sample E had the highest value of 3.83%. The increase in the ash content could be as a result of the addition of fermented sweet detar and *moringa* flours which are good sources of minerals. Elleuch et al.4

Crude fibre of the cookies increased significantly from 2.05 – 3.93%, sample E had the highest value (3.93%) while sample A had the lowest value (2.05%). Adequate crude fibre in a diet enhances gastrointestinal and cardiovascular health and research has shown the importance of crude fibre in glycaemic control and improved morbidity of diabetic patients.30

The carbohydrate content of the cookies decreased from 57.94 – 47.59% with sample A having the highest value (57.94%) while sample E had the

<table>
<thead>
<tr>
<th>Table 1: Formulation of Blends (%) for Composite Flour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blends</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>D</td>
</tr>
<tr>
<td>E</td>
</tr>
</tbody>
</table>

**Table 2: Ingredient Used in composite Cookies Preparation**

<table>
<thead>
<tr>
<th>Materials</th>
<th>Quantities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flour blend</td>
<td>100g</td>
</tr>
<tr>
<td>Sugar</td>
<td>30g</td>
</tr>
<tr>
<td>Fat</td>
<td>50g</td>
</tr>
<tr>
<td>Baking Powder</td>
<td>1.67g</td>
</tr>
<tr>
<td>Salt</td>
<td>0.5g</td>
</tr>
<tr>
<td>Water</td>
<td>20 ml</td>
</tr>
</tbody>
</table>

**Source:** Chinma et al.22
lowest value of 47.59%. This could be attributed to the addition of moringa leaf flour and fermented sweet detar flour. The lower carbohydrate content would be good for people with low energy levels.\textsuperscript{22}

**Physical Properties of the Cookies**

The result of the physical properties of cookies prepared from the composite flours of wheat, fermented sweet detar and moringa leaf is presented in Table 2. The diameter and weight of the cookies increased with increase in moringa leaf and 20% fermented sweet detar flours. Cookies from 100% wheat flour recorded the lowest weight and diameter of 14.40g and 4.46cm while sample E had the highest value of 14.95g and 4.52cm. This could be explained on the basis of increase in hydrophilic starch granules in sweet detar flour leading to moisture absorption and increase in diameter of cookies. The thickness of the cookies obtained from sample A and B were significantly different (P<0.05) from the cookies made from the other composite flours of wheat, sweet detar and moringa leaf. Sample E having the lowest value (0.84cm) while sample A had the highest value (0.99cm). The spread ratio varied from 45.05–53.80 and increased significantly (P<0.05) with the addition of fermented sweet detar and moringa flours. The cookies from 100% wheat had the lowest value of 45.05 while the cookies from sample E recorded the highest value of 53.80. The increase in the spread ratio could be attributed to the increased number of hydrophilic sites in the dough leading to increased water absorption and swelling index. This has further explained the view of Onweluzo et al.\textsuperscript{31} that the gum of sweet detar has the ability to lower shrinkage, increase water holding capacity and give better stability.

**Mineral and Vitamin content of the Cookies**

The mineral and vitamin content of cookies produced from wheat, fermented sweet detar and moringa leaf flour blends is shown in Table 3. Minerals such as Calcium, Iron, Zinc and Potassium ranged from 21.26–86.12mg/100g, 2.10–2.80mg/100g, 0.91–0.99mg/100g and 89.46–234.29mg/100g respectively. Sample E had the highest value while sample A had the lowest value. The Calcium, Iron and Potassium content of the composite cookies of wheat, sweet detar and moringa leaf.

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*Fig. 2: Production of Moringa Leaf flour*

Source: Olushola \textit{et al.} \textsuperscript{13}

*Fig. 3: Production of Cookies*

Source: Chinma \textit{et al.}\textsuperscript{22}
Table 3: Proximate Composition of Cookies Produced from wheat, Fermented Sweet Detar and *Moringa* Leaf flour blends

<table>
<thead>
<tr>
<th>Samples</th>
<th>Moisture (%)</th>
<th>Ash (%)</th>
<th>Fat (%)</th>
<th>Protein (%)</th>
<th>Carbohydrate (%)</th>
<th>Crude fibre (%)</th>
<th>E.V (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>12.34±0.02</td>
<td>1.96±0.03</td>
<td>19.50±0.02</td>
<td>6.21±0.02</td>
<td>57.94±0.01</td>
<td>2.05±0.06</td>
<td>432.10±0.10</td>
</tr>
<tr>
<td>B</td>
<td>10.89±0.01</td>
<td>2.46±0.01</td>
<td>23.33±0.00</td>
<td>8.32±0.01</td>
<td>52.45±0.02</td>
<td>2.55±0.02</td>
<td>453.05±0.10</td>
</tr>
<tr>
<td>C</td>
<td>10.98±0.01</td>
<td>2.86±0.02</td>
<td>23.31±0.02</td>
<td>8.36±0.03</td>
<td>51.36±0.03</td>
<td>3.13±0.03</td>
<td>448.67±0.01</td>
</tr>
<tr>
<td>D</td>
<td>11.45±0.02</td>
<td>3.33±0.01</td>
<td>23.11±0.00</td>
<td>8.42±0.01</td>
<td>50.02±0.25</td>
<td>3.67±0.04</td>
<td>441.75±1.04</td>
</tr>
<tr>
<td>E</td>
<td>13.10±0.01</td>
<td>3.83±0.01</td>
<td>23.12±0.01</td>
<td>8.43±0.02</td>
<td>47.59±0.04</td>
<td>3.93±0.02</td>
<td>432.16±0.01</td>
</tr>
<tr>
<td>LSD</td>
<td>0.269</td>
<td>0.034</td>
<td>0.026</td>
<td>0.024</td>
<td>0.297</td>
<td>0.104</td>
<td>1.291</td>
</tr>
</tbody>
</table>

Values are mean± standard deviation of duplicate determination
Values with different superscript within the same column are significantly different at (P<0.05).
KEY: A = Wheat flour (100%)
B = Wheat flour (75%), Fermented Sweet detar flour (20%), *Moringa* Leaf flour (5%)
C = Wheat flour (70%), Fermented Sweet detar flour (20%), *Moringa* Leaf flour (10%)
D = Wheat flour (65%), Fermented Sweet detar flour (20%), *Moringa* Leaf flour (15%)
E = Wheat flour (60%), Fermented Sweet detar flour (20%), *Moringa* Leaf flour (20%)
E.V = Energy Value
LSD = Least Significant Difference.

Table 4: Physical Properties of Cookies Produced from wheat, Fermented Sweet Detar and *Moringa* Leaf flour blends

<table>
<thead>
<tr>
<th>Samples</th>
<th>Diameter (centimeter)</th>
<th>Thickness (centimeter)</th>
<th>Weight (gram)</th>
<th>Spread Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.46±0.02</td>
<td>0.99±0.01</td>
<td>14.40±0.20</td>
<td>45.05±0.35</td>
</tr>
<tr>
<td>B</td>
<td>4.49±0.02</td>
<td>0.98±0.01</td>
<td>14.52±0.20</td>
<td>45.81±0.04</td>
</tr>
<tr>
<td>C</td>
<td>4.51±0.02</td>
<td>0.90±0.01</td>
<td>14.60±0.10</td>
<td>50.11±0.47</td>
</tr>
<tr>
<td>D</td>
<td>4.54±0.01</td>
<td>0.85±0.02</td>
<td>14.75±0.015</td>
<td>53.41±1.94</td>
</tr>
<tr>
<td>E</td>
<td>4.52±0.02</td>
<td>0.84±0.01</td>
<td>14.95±0.15</td>
<td>53.80±0.56</td>
</tr>
<tr>
<td>LSD</td>
<td>0.057</td>
<td>0.038</td>
<td>0.384</td>
<td>1.970</td>
</tr>
</tbody>
</table>

Values are mean± standard deviation of duplicate determination
Values with different superscript within the same column are significantly different at (P<0.05).
KEY: A = Wheat flour (100%)
B = Wheat flour (75%), Fermented Sweet detar flour (20%), *Moringa* Leaf flour (5%)
C = Wheat flour (70%), Fermented Sweet detar flour (20%), *Moringa* Leaf flour (10%)
D = Wheat flour (65%), Fermented Sweet detar flour (20%), *Moringa* Leaf flour (15%)
E = Wheat flour (60%), Fermented Sweet detar flour (20%), *Moringa* Leaf flour (20%)
LSD = Least Significant Difference
increased with addition of *moringa* leaf flour and the constant addition of 20% fermented sweet detar flour. The Zinc content of decreased from 0.99mg/100g – 0.91mg/100g varied significantly at (p<0.05). Deficiency of zinc had been shown to aggravate carbohydrate intolerance in certain individuals.26 Calcium intake by diabetic patients had been shown to be beneficial and likely to reduce osteoporosis in older people surviving from diabetes.33

### Table 5: Mineral and Vitamin Content of Cookies Produced from Wheat, Fermented Sweet Detar and Moringa Leaf flour blends

<table>
<thead>
<tr>
<th>Samples</th>
<th>Calcium (mg/100g)</th>
<th>Iron (mg/100g)</th>
<th>Zinc (mg/100g)</th>
<th>Potassium (mg/100g)</th>
<th>Beta Carotene (mg/100g)</th>
<th>Vitamin C (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>21.26±0.08</td>
<td>2.10±0.01</td>
<td>0.99±0.01</td>
<td>89.46±0.10</td>
<td>ND</td>
<td>2.00±0.01</td>
</tr>
<tr>
<td>B</td>
<td>39.99d±0.01</td>
<td>2.32d±0.01</td>
<td>0.92b±0.00</td>
<td>174.36d±0.03</td>
<td>39.49d±0.01</td>
<td>6.31d±0.02</td>
</tr>
<tr>
<td>C</td>
<td>56.06c±0.03</td>
<td>2.53c±0.02</td>
<td>0.91b±0.01</td>
<td>191.61c±0.62</td>
<td>75.38c±0.03</td>
<td>10.25c±0.08</td>
</tr>
<tr>
<td>D</td>
<td>72.06b±0.03</td>
<td>2.67b±0.01</td>
<td>0.92b±0.01</td>
<td>202.01b±0.12</td>
<td>93.66b±0.02</td>
<td>16.97b±0.02</td>
</tr>
<tr>
<td>E</td>
<td>86.12a±0.01</td>
<td>2.80a±0.01</td>
<td>0.91b±0.00</td>
<td>234.29a±0.05</td>
<td>119.17a±0.17</td>
<td>19.38a±0.01</td>
</tr>
<tr>
<td>LSD</td>
<td>0.122</td>
<td>0.013</td>
<td>0.021</td>
<td>0.779</td>
<td>0.219</td>
<td>0.104</td>
</tr>
</tbody>
</table>

Values are mean± standard deviation of duplicate determination. Values with different superscript within the same column are significantly different at (P<0.05).

**KEY:**
- A = Wheat flour (100%)
- B = Wheat flour (75%), Fermented Sweet detar flour (20%), Moringa Leaf flour (5%)
- C = Wheat flour (70%), Fermented Sweet detar flour (20%), Moringa Leaf flour (10%)
- D = Wheat flour (65%), Fermented Sweet detar flour (20%), Moringa Leaf flour (15%)
- E = Wheat flour (60%), Fermented Sweet detar flour (20%), Moringa Leaf flour (20%)
- LSD = Least Significant Difference
- ND = Not Detected

### Table 6: Sensory Scores of Cookies Produced from wheat, Fermented Sweet Detar and Moringa Leaf flour blends

<table>
<thead>
<tr>
<th>Samples</th>
<th>Appearance</th>
<th>Aroma</th>
<th>Crispness</th>
<th>Taste</th>
<th>Texture</th>
<th>General Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>8.26a</td>
<td>7.60a</td>
<td>7.33a</td>
<td>7.60a</td>
<td>7.46a</td>
<td>8.13a</td>
</tr>
<tr>
<td>B</td>
<td>6.13b</td>
<td>5.60b</td>
<td>6.40b</td>
<td>5.46b</td>
<td>6.26b</td>
<td>5.96b</td>
</tr>
<tr>
<td>C</td>
<td>5.26bc</td>
<td>5.46b</td>
<td>6.13b</td>
<td>5.86b</td>
<td>6.00bc</td>
<td>5.53bc</td>
</tr>
<tr>
<td>D</td>
<td>5.40b</td>
<td>5.60bc</td>
<td>6.06b</td>
<td>5.80b</td>
<td>6.13bc</td>
<td>5.13bc</td>
</tr>
<tr>
<td>E</td>
<td>4.20b</td>
<td>4.46c</td>
<td>4.86c</td>
<td>4.40c</td>
<td>5.33c</td>
<td>4.66c</td>
</tr>
<tr>
<td>LSD</td>
<td>1.07</td>
<td>0.87</td>
<td>1.27</td>
<td>1.15</td>
<td>0.87</td>
<td>0.87</td>
</tr>
</tbody>
</table>

Values with different superscript within the same column are significantly different at (P<0.05).

**KEY:**
- A = Wheat flour (100%)
- B = Wheat flour (75%), Fermented Sweet Detar flour (20%), Moringa Leaf flour (5%)
- C = Wheat flour (70%), Fermented Sweet detar flour (20%), Moringa Leaf flour (10%)
- D = Wheat flour (65%), Fermented Sweet detar flour (20%), Moringa Leaf flour (15%)
- E = Wheat flour (60%), Fermented Sweet detar flour (20%), Moringa Leaf flour (20%)
- LSD = Least Significant Difference
Vitamins content (beta-carotene and vitamin C) ranged from 0.00mg/100g–119.17mg/100g and 2.00–19.38mg/100g respectively. Sample E recorded the highest value while sample A had the lowest value. The beta-carotene and vitamin C content of the composite cookies were significantly (p<0.05) higher than 100% wheat cookies. This could be explained on the basis of increased in moringa flour which is high in minerals content. Fugile and Mishra et. al. 12

Sensory Properties of the Cookies
The sensory properties of cookies prepared from wheat, fermented sweet detar and moringa leaf composite flours is shown in Table 4. Cookies produced from sample A (control) were most accepted followed by sample B and C. Sample E was least accepted. This work has demonstrated that acceptable cookies can be produced from wheat, fermented sweet detar and moringa leaf flour blends. The wheat cookies were most acceptable but all the cookies were accepted except sample E.

Conclusion
Cookies were produced from composite flours of wheat, fermented sweet detar and moringa leaf with improved nutrients and were generally accepted. The composite cookies had better physical, and nutrient composition. Therefore all the formulations could be used in cookies production according to energy and nutrients needs.

The production of cookies from these crops would motivate farmers to plant it, diversify the uses, provide nutrient rich and nutritious foods for malnourished children, the elderly and people generally in Nigeria and Africa.

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References


