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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 from1.96 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.

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Keywords

Cookies;
Composite flour;
Micronutrient;
Moringa leaf;
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Introduction

Cookies are baked product that are increasingly becoming very important snack foods due to their taste, crispness, digestibility, ready to eat, convenience and relatively stable shelf life. Cookies have lower moisture content and softer chewer texture than biscuits.[1] 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

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fruits and eggs.[2] Generally cookies comprises of; 18.5% fat, 78.23% carbohydrates, 1.0% ash, 7.1% protein and 0.85% salt[3]. 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[4] 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.[5] 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.[6] Legumes flours usually contain higher protein and calories when combined with other crops.[7]

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.[8] In Nigeria, wheat is not grown due to climatic reasons therefore it is usually imported using huge sums of money.[9] Therefore the use of composite flour is promoted in Nigeria to decrease wheat importation and encourage production of protein enriched crops and products.[10]

Moringa oleifera belongs to the genus Moringa and is one of the commonest specie known.[11] *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).[12]

The leaves, foliage, seeds and every part of the Moringa plant is nutrient dense and of food value to both animals and human beings.[13]

Sweet detar (*Detarium microcarpum*) is an under-utilized legume plant that belongs to the family Fabaceae.[14] 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.[15] In Nigeria, it is known by different names, by Igbo's as '*ofor*', Yoruba's as '*ogbogbo*' and Hausa's as '*taura*'.[16] '*ofor*' can be used as thickeners, stabilizers or processed into condiments or fermented food products.[15] The Gum from D. *microcarpum* can also be used to increase water absorption and mixing tolerance index of dough.[17] It was also documented that the addition of this gum to fruit products also improved their stability during storage.[18]

Reports by Researchers have shown that sweet detar offers protection against syphilis, dysentery, bronchitis, leprosy, sore throat, malaria and meningitis.[19] 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) [20] and vitamin C (3.2mg). The legume however, contains some anti-nutrients such as saponins, phytates and cyanide.[21] 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.[15]

The aim of this work is to produce and evaluate the quality of cookies from the composite flours of wheat, sweet detar and *moringa* 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.*[15] 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.[13] 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 polyethene bags and stored at ambient temperature of 32°C. The production process is shown in Fig. 2.

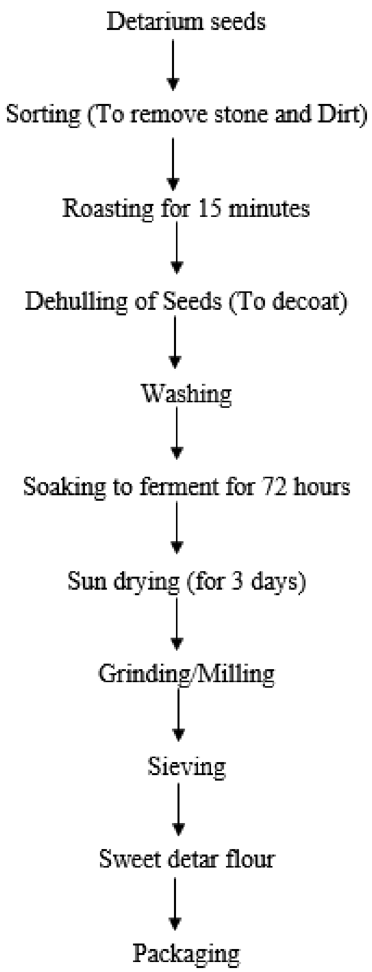

Fig. 1: Production of Fermented Sweet Detar flour

Source: Igbabul *et al.* [15]

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.[24]

Physical Properties of the Cookies

The physical properties were determined by the American Association of Cereal Chemists (AACC) methods.[25] 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.[23]

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 gastro intestinal 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 1: Formulation of Blends (%) for Composite Flour

Blends	WF %	FSDF %	MLF %
A	100	0	0
B	75	20	5
C	70	20	10
D	65	20	15
E	60	20	20

KEYS
WF = Wheat flour
FSDF = Fermented Sweet detar flour
MLF = Moringa Leaf flour

Table 2: Ingredient Used in composite Cookies Preparation

Materials	Quantities
Flour blend	100g
Sugar	30g
Fat	50g
Baking Powder	1.67g
Salt	0.5g
Water	20 ml

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.[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.*[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

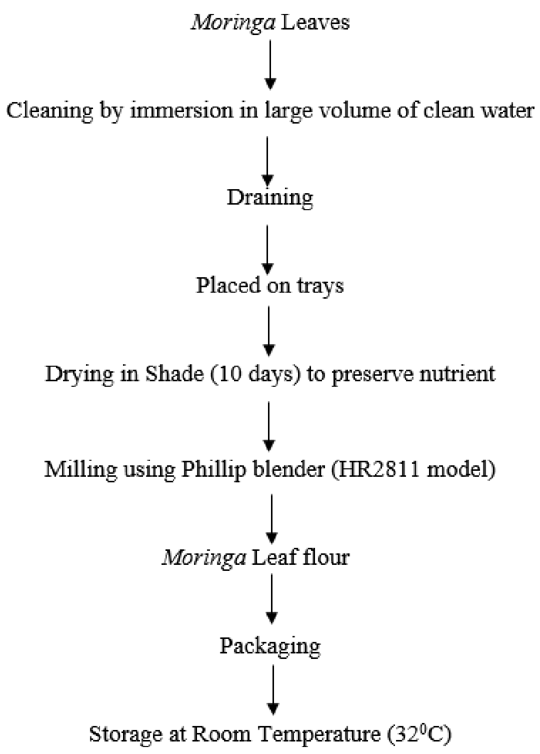

Fig. 2: Production of Moringa Leaf flour

Source: Olushola *et al.*[13]

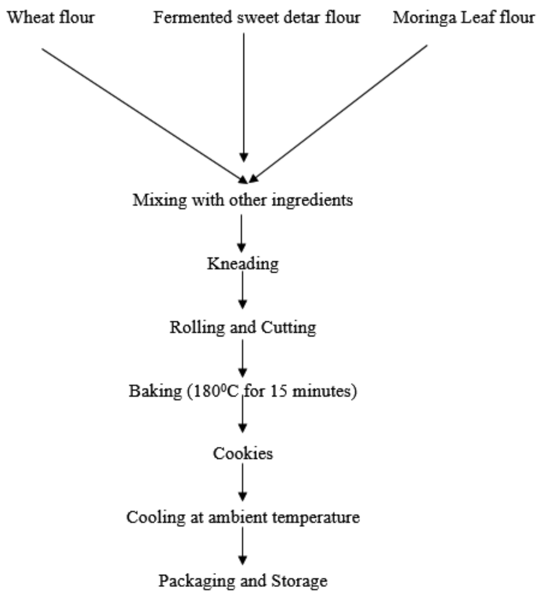

Fig. 3: Production of Cookies

Source: Chinma *et al.*[22]

Table 3: Proximate Composition of Cookies Produced from wheat, Fermented Sweet Detar and *Moringa* Leaf flour blends

Samples	Proximate Composition (%)						
	Moisture	Ash	Fat	Protein	Carbohydrate	Crude fibre	E.V (kcal)
A	$12.34^{b}\pm0.02$	$1.96^{e}\pm0.03$	$19.50^{d}\pm0.02$	$6.21^{d}\pm0.02$	$57.94^{a}\pm0.01$	$2.05^{e}\pm0.06$	$432.10^{d}\pm0.10$
B	$10.89^{d}\pm0.01$	$2.46^{d}\pm0.01$	$23.33^{c}\pm0.00$	$8.32^{c}\pm0.01$	$52.45^{b}\pm0.02$	$2.55^{d}\pm0.02$	$453.05^{a}\pm0.10$
C	$10.98^{d}\pm0.01$	$2.86^{c}\pm0.02$	$23.31^{c}\pm0.02$	$8.36^{b}\pm0.03$	$51.36^{c}\pm0.03$	$3.13^{c}\pm0.03$	$448.67^{b}\pm0.01$
D	$11.45^{c}\pm0.02$	$3.33^{b}\pm0.01$	$23.11^{b}\pm0.00$	$8.42^{a}\pm0.01$	$50.02^{d}\pm0.25$	$3.67^{b}\pm0.04$	$441.75^{c}\pm1.04$
E	$13.10^{a}\pm0.01$	$3.83^{a}\pm0.01$	$23.12^{a}\pm0.01$	$8.43^{a}\pm0.02$	$47.59^{e}\pm0.04$	$3.93^{a}\pm0.02$	$432.16^{d}\pm0.01$
LSD	0.269	0.034	0.026	0.024	0.297	0.104	1.291

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

Samples	Diameter (entimeter)	Thickness (centimeter)	Weight (gram)	Spread Ratio
A	$4.46^{b}\pm0.02$	$0.99^{a}\pm0.01$	$14.40^{ac}\pm0.20$	$45.05^{c}\pm0.35$
B	$4.49^{ab}\pm0.02$	$0.98^{a}\pm0.01$	$14.52^{ab}\pm0.20$	$45.81^{c}\pm0.04$
C	$4.51^{ab}\pm0.02$	$0.90^{b}\pm0.01$	$14.60^{ba}\pm0.10$	$50.11^{b}\pm0.47$
D	$4.54^{a}\pm0.01$	$0.85^{c}\pm0.02$	$14.75^{a}\pm0.015$	$53.41^{a}\pm1.94$
E	$4.52^{a}\pm0.02$	$0.84^{c}\pm0.01$	$14.95^{a}\pm0.15$	$53.80^{a}\pm0.56$
LSD	0.057	0.038	0.384	1.970

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

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

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

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

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 [34] 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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