



Nutritional and Sensory Qualities of Cookies from Wheat, Trifoliate Yam and Moringa Seed Flours

Fayomi, O. I. ^{a*}, Anadi, V. N. ^b and Faasema, J. J. ^c

^a Department of Food Science and Technology, Joseph Sarwuan Tarka University, Makurdi, Benue State, Nigeria.

^b Department of Home Economics, Federal College of Education Odugbo, Benue State, Nigeria.

^c Department of Agricultural Extension and Communication, Joseph Sarwuan Takar University, Makurdi, Benue State, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/EJNFS/2023/v15i111360

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/108003>

Original Research Article

Received: 25/08/2023
Accepted: 01/11/2023
Published: 21/11/2023

ABSTRACT

Nutritional and sensory qualities of cookies from wheat, trifoliate yam and moringa seed flour were investigated. The formulated blends (%) were 100:0:0, 85:10:5, 75:20:5, 65:30:5, 55:40:5 and 45:50:5 % wheat, trifoliate yam and moringa seed flour, with 100 % wheat flour serving as control. The cookies samples were subjected to proximate, physical, vitamin, mineral and sensory analysis using standard methods. The study revealed that addition of trifoliate yam and *Moringa* seed flour to wheat in cookies formulation significantly ($P < 0.05$) increased the moisture, ash, crude fibre, crude fat and protein contents of wheat-based cookies. The result of the physical properties showed no significant ($P > 0.05$) difference for diameter (cm) of the cookies. However, a significant ($P < 0.05$) difference was observed for thickness, weight and spread ratio. The minerals and vitamins contents such as magnesium, calcium, potassium and iron, ascorbic acid (vitamin C) and

*Corresponding author: Email: yomifayomi3@gmail.com;

β -carotene (pro-vitamin A) increased while the niacin (vitamin B₃) and pyridoxine (B₆) decreased as the level of trifoliolate yam flour addition increased. Sensory attributes of this study showed that the trifoliolate yam flour could be incorporated up to the levels of 10 and 20 % in the wheat and moringa flour without greatly influencing the organoleptic characteristics of the cookies. Trifoliolate yam flour and moringa seed flour can be used in the Addition of wheat flour in cookies and confectionery production due to its high nutritional contents. Trifoliolate yam flour addition in wheat flour be encouraged in cookies production as this compared favourable with the wheat-based cookies and that shelf-life study should be carried out to ascertain the cookies storage stability.

Keywords: Nutrition; sensory; cookies; trifoliolate yam; proximate; mineral; vitamin properties.

1. INTRODUCTION

“Snacks, the light, fast and ready-to-eat foods are demanded in large quantities mainly in towns and city centres where people consume them as refreshments or quick foods, to quench hunger, or at times as a substitute for the real meal” [1]. “In recent times, snack products are increasingly gaining global acceptance due to job demands, convenience driven lifestyles and dietary habits” [2]. “In Nigeria, snack categories range from the traditional snacks produced from indigenous cereals and legumes such as maize and groundnut (*kulikuli*, *donkwa*, *guguru*, *Aadun*) to other snacks (biscuits, cookies) produced from wheat and other cereals of foreign origin. Cookies are one of the best-known quick snack products” [3]. “They are popular examples of bakery product of ready-to-eat snack that possess several attractive features including wide consumption, more convenient with long shelf-life and have the ability to serve as vehicles for important nutrient” [4]. “Also, cookies can therefore serve as a vehicle for delivering important nutrients if made readily available to the population” [5]. Uthumporn et al. [6] reported “cookies as Foods with high nutritional value are in great demand for proper functioning of body systems and potential health benefits. As a result, value-added foods or functional foods with higher level of dietary fiber and antioxidant have been developed, especially in bakery products such as cookies”. “Cookies and other bakery products have now become loved fast-food products for every age-group, because they are easy to carry about, tasty to eat, cholesterol-free, containing digestive and dietary principles of vital importance and reasonably cheap” [3]. “They can be made from hard dough, hard sweet dough or soft dough” [3,7,8]. “The main ingredients of cookies are wheat flour, fat (margarine) and sugar and water, while other ingredients such as milk, salt, aerating agent, emulsifier, flavor and colour can be included.

They can also be enriched or fortified with other ingredients in order to meet specific nutritional or therapeutic needs of consumers” [4].

“The demand for wheat flour has significantly increased due to increase in its utilization by food and allied industries in Africa, especially Nigeria, it is expected that owing the strong urbanization and population growth, the increase in wheat consumption at the expense of indigenous product was increase” [9]. “However, a major challenge to meeting this increasing demand has necessitated sourcing for local substitutes. Although some other cereal grains and tubers have been successfully used for this purpose, there is an increasing interest in fruits rich in dietary fibre which has been associated with health-promoting abilities. Consumption of foods with high dietary fibre has been reported in prevention and management of chronic diseases such as cardiovascular diseases, diabetes and colon cancer” [10]. “Trifoliolate yam (*Dioscorea dumetorum*) is an under-exploited but high yielding yam species. It has also been reported to be nutritionally superior to the commonly consumed yams with high protein and minerals” [11]. “It has starch grains that are smaller, more digestible than those of other yam species. Trifoliolate yam tuber however, contains some anti-nutrient contents as a result of which slight bitterness may be experienced. In addition, this yam species hardens few days after harvest leading to reduction in moisture and starch content and increase in sugar as well as structural polysaccharides” [12]. Intensive processing like prolonged soaking and blanching are expected to eliminate these defects. Transforming its tubers into edible flour constitutes a means of conferring a long-term value onto it.

“The moringa plant derives this name based on its uses, particularly with regard to medicine and nutrition” [13]. “It is considered one of the most useful tree in the world because almost all parts of this plant can be used as food [14]. In

numerous parts of the world including Africa, the utilization of *Moringa oleifera* as a food fortificant is on the increases” [15].

Increase in human population and demand for healthy and nutritious food products, especially bakery products have necessitated the increase the nutritional value of cookies by supplementation, reducing malnutrition problems by making healthy cookies available to people in rural and urban areas and increase the utilization of raw materials. This research work was therefore geared towards evaluating the nutritional and sensory qualities of cookies from wheat, trifoliate yam and moringa seed flour.

2. MATERIALS AND METHODS

2.1 Source of Raw Materials

Wheat flour and other baking ingredients such as eggs, baking powder, fat, sugar, and salt were obtained from modern market Makurdi, trifoliate yam and moringa seed flour was purchased from Wadata market Makurdi, Benue State Nigeria. Equipment such as food processor, mixing

bowls, measuring cups and spoons, rolling pin, cookie cutter, baking sheet, oven, cooling rack weighing balance were obtained in Food Processing Laboratory of Department of Food Science and Technology, Joseph Sarwuan Tarka University, Makurdi. All other chemical used were of analytical grade. The raw materials were properly cleaned by removing extraneous matter prior to their subjection to different processing treatment.

2.2 Sample Preparation

2.2.1 Preparation of trifoliate yam Flour

The freshly harvested yam tubers were washed, drained and peeled. The peeled tubers were weighed at 2000g then was sliced, blanched at 60°C for 10 min and dried in the hot air oven (LCI/12H/GLAD/ING) at 80 °C for 72h. The dried chips were milled into flour with hammer mill (The model 90 SN/LN) and sieved with 250 µm mesh sieve. The flour samples were sealed in polythene bag [11] as shown in Chart 1.

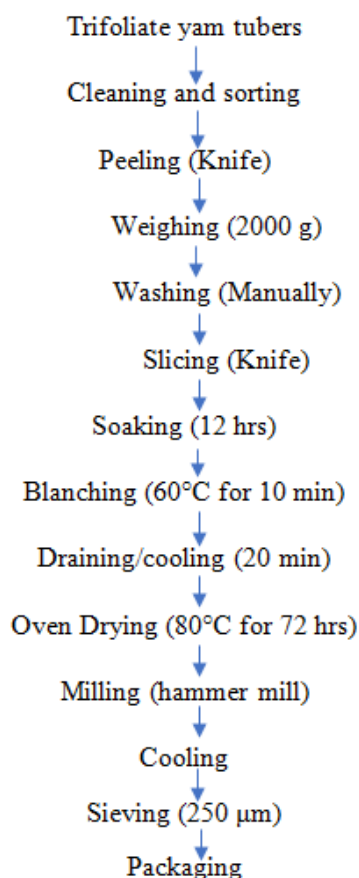


Chart 1. Production of Trifoliate Yam Flour

Source: Abiodun et al. [11]

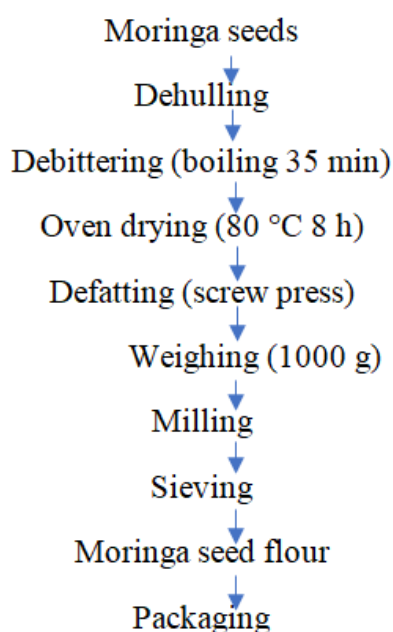


Chart 2. Flow Chart for the Production of Moringa Seed Flour

Source: Khalaf et al., [16]

2.2.2 Preparation of *Moringa* Seed Flour

Moringa seeds were prepared by dehulled and debittered by ordinary boiling in clean water for 35 min using a 1:30 w/v ratio. The debittered seeds were oven-dried (LCI/12H/GLAD/ING) at 80°C for 8h according to Khalaf et al., 2019 method. The debittered seeds were defatted by using screw press device to obtain the cold pressed crude oil, then weighing of 1000g of the defatted moringa seed then milled, (All double) passed through 0.4 mm mesh sieves as shown in Chart 2.

2.3 Formulation of Wheat, Trifoliolate Yam and *Moringa* Seed Flour Blends for Cookies Production

The wheat, trifoliolate yam and *Moringa* seed flours were used for the formulation of cookies and mixed in different proportions. Sample A was made up of 100% wheat flour 0% Trifoliolate yam flour and 0% moringa seed flour (100:0:0) and was served as a control sample. sample B on the other hand were comprised of 85% wheat flour, 10% Trifoliolate yam flour, and 5% Moringa seed flour (85:10:5), sample C was comprise of 75% wheat flour,20% Trifoliolate yam flour and 5% moringa seed flour (75:20:5), sample D was ,60% wheat flour, 30% Trifoliolate yam flour and 5% moringa seed flour (60:30:5) ,sample E will

be comprise of 55% wheat flour,40% Trifoliolate yam flour and 5% moringa seed flour (55:40:5) and finally sample F were comprise of 45% wheat flour,50% Trifoliolate yam flour and 5% moringa seed flour (45:50:5).The different wheat flour, trifoliolate yam and moringa seed flour formulated for the cookies as shown in the Table 1.

2.4 Method of preparing Cookies from Wheat, Trifoliolate Yam and *Moringa* Seed Flour Blends

Cookies were prepared according to the method of [17] with some modifications in the recipes: flour 100g, sugar 50g, vegetable shortening 50g, baking powder 3.3g, egg 26.5mL, salt 2g and the quantity of water varies. The dry ingredients (flour, sugar, salt and baking powder) will be thoroughly mixed in a bowl by hand for 3 minutes. Vegetable shortening were added and mixed until uniform. Egg was added and the mixture kneaded. The batter was rolled and cut with a 50mm diameter cookies cutter. The cookies were placed on baking trays, leaving 25mm spaces in between and baked at 180°C for 10 mins in the baking oven. Following baking, the cookies were allowed to cool at ambient temperature, packed and stored at 23°C prior subsequent analysis and sensory evaluation as shown in Chart 3.

Table 1. Formulation of Blends of the Composite Flour (%) for Cookies Production

Sample Code	Wheat Flour (%)	Trifoliolate Yam Flour (%)	Moringa Seed Flour (%)
A (control)	100	0	0
B	85	10	5
C	75	20	5
D	65	30	5
E	55	40	5
F	45	50	5

Key

A (control) = 100 % wheat flour + 0% trifoliolate yam flour + 0% Moringa seed flour

B = 85 % wheat flour + 10% trifoliolate yam flour + 5 % Moringa seed flour

C = 75 % wheat flour + 20% trifoliolate yam flour + 5 % Moringa seed flour

D = 65 % wheat flour + 30 % trifoliolate yam flour + 5 % Moringa seed flour

E = 55 % wheat flour + 40 % trifoliolate yam flour + 5 % Moringa seed flour

F = 45 % wheat flour + 50 % trifoliolate yam flour + 5 % Moringa seed flour

Table 2. Recipes for Blends of Wheat, Trifoliolate Yam and Moringa Seed Flours

Sample code	Wheat Flour (g)	Trifoliolate yam Flour (g)	Moringa seed Flour(g)	Sugar	Fat (g)	Baking powder(g)	Egg	Salt(g)
A	300	0	0	100	100	10	1	1.5
B	255	30	15	100	100	10	1	1.5
C	225	60	15	100	100	10	1	1.5
D	195	90	15	100	100	10	1	1.5
E	165	120	15	100	100	10	1	1.5
F	135	150	15	100	100	10	1	1.5

Key

A (control) = 100 % wheat flour + 0% trifoliolate yam flour + 0% Moringa seed flour

B = 85 % wheat flour + 10% trifoliolate yam flour + 5 % Moringa seed flour

C = 75 % wheat flour + 20% trifoliolate yam flour + 5 % Moringa seed flour

D = 65 % wheat flour + 30 % trifoliolate yam flour + 5 % Moringa seed flour

E = 55 % wheat flour + 40 % trifoliolate yam flour + 5 % Moringa seed flour

F = 45 % wheat flour + 50 % trifoliolate yam flour + 5 % Moringa seed flour



Chart 3 : Flow Chart Showing the Production of Cookies

Source: Chinma et al. [17] Modified

2.5 Determination of Proximate Composition of Cookies

The proximate composition of the cookies flour was determined using the methods of AOAC [18] and Carbohydrate content was determined by difference according to Ihekoronye and Ngoddy [9].

2.5.1 Moisture determination

Moisture content was determined using the air oven dry method (AOAC, 2015). A clean dish with a lid was dried in an oven at 100 °C for 30 min. It was cooled in desiccators and weighed. Two (2) grams of sample was weighed into the dish. The dish with its content was then be put in the oven at 105 °C and dried to a fairly constant weight. The loss in weight from the original sample (before heating) was reported as percentage moisture.

$$\% \text{ Moisture} = \frac{\text{Weight loss } (W_2 - W_3)}{\text{Weight of Sample } (W_2 - W_1)}$$

Where:

W_1 = weight of dish, W_2 = weight of dish + sample before drying, W_3 = weight of dish + sample after drying.

2.5.2 Crude protein determination

The Kjeldahl method as described by AOAC (2015) was used to determine the percentage crude protein. Two (2) grams of sample was weighed into a Kjeldahl digestion flask using a digital weighing balance (3000g x 0.01g 6.6LB). A catalyst mixture weighing 0.88g (96% anhydrous sodium sulphate, 3.5% copper sulphate and 0.5% selenium dioxide) will be added. Concentrated sulphuric acid (7 mL) was added and swirled to mix content. The Kjeldahl flask was heated gently in an inclined position in the fume chamber until no particles of the sample was adhered to the side of flask. The solution was heated more strongly to make the liquid boil with intermittent shaking of the flask until clear solution was obtained. The solution was allowed to cool and diluted to 25 mL with distilled water in a volumetric flask. Ten (10) mL of diluted digest was transferred into a steam distillation apparatus. The digest was made alkaline with 8 mL of 40% NaOH. To the receiving flask, 5 mL of 2% boric acid solution was added and 3 drops of mixed indicator was dropped. The distillation apparatus was connected to the receiving flask with the delivery tube dipped into the 100mL

conical flask and titrated with 0.01 HCl. A blank titration was done. The percentage nitrogen was calculated from the formula:

$$\% \text{ Nitrogen} = \frac{(S - B) \times 0.0014 \times 100 \times D}{\text{Sample Weight}}$$

Where,

S = sample titre, B = Blank titre, S - B = Corrected titre, D = Diluted factor

% Crude Protein = % Nitrogen x 6.25 (correction factor).

2.5.3 Crude fat determination

Fat was determined using Soxhlet method as described by AOAC (2015). Sample was weighed into a thimble and loose plug fat free cotton wool was fitted into the top of the thimble with its content inserted into the bottom extractor of the Soxhlet apparatus. Flat bottom flask (250 mL) of known weight containing 150 – 200 mL of 40 – 60 °C hexane was fitted to the extractor. The apparatus was heated and fat extracted for 8h. The solvent was recovered and the flask (containing oil and solvent mixture) was transferred into a hot air oven (GENLAB, England B6S, serial no: 85K054) at 105 °C for 1 h to remove the residual moisture and to evaporate the solvent. It was later transferred into desiccator to cool for 15 min before weighing. Percentage fat content was calculated as follows

$$\% \text{ Crude Fat} = \frac{\text{Weight of Extracted Fat}}{\text{Weight of Sample}} \times 100$$

2.5.4 Crude fibre determination

The method described by AOAC (2015) was used for fibre determination. Two (2) grams of the sample was extracted using Diethyl ether. This was digested and filtered through the california Buchner system. The resulting residue was dried at 130 ± 2°C for 2 h, cooled in a dessicator and weighed. The residue was then be transferred in to a muffle furnace (Shanghai box type resistance furnace, No: SX2-4-10N) and ignited at 550°C for 30 min, cooled and weighed. The percentage crude fibre content was calculated as:

$$\% \text{ Crude Fibre} = \frac{\text{Loss in Weight after Incineration}}{\text{Weight of Original Food}} \times 100$$

2.5.5 Ash determination

The AOAC (2015) method for determining ash content was used. Two (2) gram of sample was weighed into an ashing dish which had been pre-heated, cooled in a desiccator and weighed soon after reaching room temperature. The crucible and content was heated in a muffle furnace at 550°C for 6-7 h. The dish was cooled in a desiccator and weighed soon after reaching room temperature. The total ash was calculated as percentage of the original sample weight.

$$\% \text{ Ash} = \frac{(W_3 - W_1)}{(W_2 - W_1)} \times 100$$

Where:

W₁ = Weight of empty crucible,

W₂ = Weight of crucible + sample before ashing,

W₃ = Weight of crucible + content after ashing.

2.5.6 Carbohydrate determination

Carbohydrate content was determined by difference according to Ihekoronye and Ngoddy [9] as follows:

$$\% \text{ Carbohydrate} = 100 - (\% \text{ moisture} + \% \text{ protein} + \% \text{ fat} + \% \text{ ash} + \% \text{ fibre})$$

2.6 Determination of Physical Characteristics of the Cookies and Composite Cookies

2.6.1 Weight of the cookies samples

The weight of the cookies was determined according to the method of Ayo et al., [19]. The weights of cookies samples were determined with the aid of a weighing balance (model) immediately after cooling.

2.6.2 Diameter of the cookies samples

The diameter (D) of the cookies was determined according to the method of AACC [20]. Four cookies were placed edge to edge and their total diameter was measured with the aid of a ruler. The cookies were rotated at angles of 90° for duplicate reading. The experiment was repeated twice and average diameter was recorded in millimeter.

2.6.3 Thickness of the cookies samples

The thickness of the cookies was determined according to the method of Ayo et al. [19]. The cookies thickness was measured with the aid of a digital vernier caliper with 0.01mm precision.

2.6.4 Spread ratio of the cookies samples

The spread ratio was determined according to method of Okaka and Isieh [21]. The diameter and thickness of the unbaked cut out dough and baked dough was measured using the vernier caliper.

Spread ratio= (baked cookies diameter-unbaked cookies diameter)/ (baked cookies thickness-unbaked cookies thickness)

2.7 Determination of the Mineral Content (mg/100g) of Cookies

2.7.1 Determination of iron

Standard solution containing 100 mg/mL of Fe³⁺ ions was prepared from 1 g pure iron wire. The wire was dissolved in 20 mL concentrated HNO₃, boiled in water bath and diluted to 1000 mL with distilled water. Standard solutions with concentrations 0, 0.5, 1.0, 2.0 and 4.0 ppm was prepared. Two milliliter of sample aliquot was diluted to 100 mL and was used to determine the absorbance of the sample using an atomic absorption spectrophotometer (Uniscop Surgifriends Medicals, England) at 510 nm. The standard and samples absorbance were noted and concentration of iron in the sample was determined from the standard curve.

2.7.2 Procedure for the determination of magnesium

Magnesium was determined according to the method described by [18]. One gram (1g) of magnesium ribbon was accurately weighed and dissolved in 10 mL concentrated HCl. The solution was then boiled and evaporated almost to dryness on a water bath. De-ionized water was added and the solution was transferred into a 100 mL volumetric flask. The solution was met to mark with de-ionized water. From this stock solution which contains 1000 mg/mL of Mg²⁺ ions, four standard solutions of concentrations 0.0, 0.5, 1.0 and 1.5 ppm were prepared. Strontium chloride solution was added to magnesium solutions such that there is 1500 /mg of strontium ions in the final solution. The concentration was determined using calibration curves.

2.7.3 Determination of potassium

Potassium determination was by Flame Photometry [18]. One (1) gram of sample was dissolved in 20 mL of acid mixture (650 mL of concentrated HNO₃; 80 mL PCA; 20 mL conc.

H₂SO₄) and aliquots of the diluted clear digest were taken for photometry using Flame analyzer.

2.7.4 Determination of calcium

Calcium was determined using the atomic absorption spectrophotometer. Calcium carbonate (2.495 g) was dissolved and diluted to 100 mL with de-ionized water. This solution contains 1000 mg Ca²⁺ ions and from this stock solution, calcium standard of the following concentration levels 0.0, 3.0, 6.0, 9.0 were prepared. The absorbance of both the sample and the standard working aliquot were determined in the atomic absorption spectrophotometer (Uniscop Surgifriends, England) at 239.9nm. The concentration of the test mineral in the sample was calculated with reference to the graph (standard curve) and obtained as follows:

2.8 Determination of Vitamins Content of the Cookies

2.8.1 Determination of pro-vitamin A

The AOAC [18] method with colourimeter was used for the determination. Pyrogallol (antioxidant) was added to 2 g sample prior to saponification with 200 mL alcohol KOH. The saponification took place in water bath for 30 minutes. The sample solution was transferred to a separatory funnel where water was added. The sample solution was extracted with 1.5 mL of hexane. The extract was washed with equal volume of H₂O. The extract was filtered through filter paper containing 5 g anhydrous Na₂SO₄ into a volumetric flask. The filter paper was rinsed with hexane and made up to volume. The hexane was evaporated from the solution and blank. One millilitre chloroform and SbCl₃ solution was added to the extract and blank. The reading of the solution and blank were taken from the colourimeter adjusted to zero absorbance. Standard curve was prepared using USP vitamin A reference standard ranging from 0.07 to 0.7.

2.8.2 Determination of vitamin B₃

These were determined using the method described by AOAC [18]. Five grams (5 g) of homogenized sample was weighed into 100 mL volumetric flask. 0.1 N hydrogen chloride was added and mixed then autoclaved for 30 minutes at 121 °C. The samples were allowed to cool. Interfering substances were precipitated by adjusting the pH to 6.0 followed immediately by

readjusting the pH to 4.5. This was then diluted to volume with water and filtered. Five mills (5 mL) of 6 % enzyme (mylase 100) was added and incubated for 3 hours at 45-50 °C. This was then cooled and pH adjusted to 3.5 and diluted with water to volume, mixed and filtered. 10 mL of diluted extract was oxidized by passing through a sepak C18 cartridge followed by 5 mL 0.01 m phosphate buffer at pH 7.0. The vitamins were separated by high performance liquid chromatography (HPLC) (Model: BLC-10/11, Buck scientific, USA) using a 4.6 mm x 25 cm ultra-sphere ODS (operational data store), 5 column or equivalent and detected by florescence at 360 nm/415 nmex/em. The pyridoxine, riboflavin and thiamin contents were measured by the calculation below.

2.8.3 Determination of folic acid (Vitamin B₉)

Folic acid (vitamin B₉) was determined by microbiological assay according to AOAC [18]. A sample of 2g was weighed and 30 mL buffer was added in a flask and closed using aluminum foil. The sample was autoclaved at 121 °C for 10 minutes, cooled to room temperature in running water, quantitatively transfer into a 200 mL volumetric flask and was diluted to the volume with deionized water. This was filtered through filter paper then the filtrate was collected in a 125 mL Erlenmeyer flask. Standard solutions were prepared in tubes then autoclaved at 121 °C for 10 minutes and finally cooled to room temperature with running water. Inoculation of the samples were done and incubated for 16hrs at 37 °C.

2.9.4 Determination of vitamin B₁₂

Vitamin B₁₂ was determined by Liquid Chromatography Tandem Mass Spectrometry (LC-MS/MS) as described by Jung-Hoon et al. (2015). One gram (1 g) sample was mixed well with 10 mM chloroform in a 50 mL Falcon tube for 1 min. Then, the mixture was centrifuged at 4°C, 5000 rpm for 15 min. The supernatant was filtered through a 0.2 µm nylon filter. After flowing the standard 5% methanol in H₂O 5 mL, cartridge thereby removing the residual water. The sample was then purified by solid phase extraction, using the Oasis hydrophilic-lipophilic balance (HLB) 6cc 200 mg cartridge. The cartridge was first pre-equilibrated with 5 mL of methanol and 5 mL of H₂O and adjusted to pH 4.2 with acetic acid. Then, 5 mL of the sample was injected onto the cartridge, followed by washing with 5 mL of 5% methanol in H₂O to eliminate the residual moisture. Finally, the vitamin B₁₂ was eluted with

5 mL of methanol. The sample eluate was concentrated with nitrogen gas and then re dissolved in 1 mL of H₂O before analysis by LC-MS/MS.

2.9 Sensory Evaluation of the Cookies and composite cookies

“Sensory evaluation of the cookies was carried out according to the method” described by [9]. A panel of fifteen members consisting of students and members of staff in Food Science and Technology Department, Joseph Sarwuan Tarkaa University, Makurdi, Benue State Nigeria, was chosen based on their familiarity and experience with wheat-based cookies for sensory evaluation. Cookies produced from each flour blend, along with the reference sample was presented in coded form and was randomly presented to the panelists. The panelists was provided with portable water to rinse their mouth between evaluations. However, a questionnaire describing the quality attributes (appearance, taste, flavour, texture crispiness and overall acceptability) of the cookies was given to each panelist. Each sensory attribute was rated on a 9-point hedonic scale (1 = dislike extremely and 9 = like extremely).

2.11 Statistical Analysis

The data generated were subjected to analysis of variance (ANOVA) and means were separated using Duncans multiple range test (D M R T) while significance deference was tested at 5 % level of probability.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Cookies from Wheat, Trifoliate Yam and Moringa Seed Flour Blends

The proximate composition of wheat, trifoliate yam and moringa seed flour composite cookies is presented in Table 3. The moisture, ash, fiber, fat and protein contents ranged from 3.25-6.68%, 2.33-5.72%, 1.21-3.96%, 19.10-22.83% and 11.05-22.08%. The carbohydrate contents however decreased from 63.09 % to 38.75% with increased level of trifoliate yam addition while moringa seed flour was held constant. There was a significant increase ($P<0.05$) in the moisture content of the cookies from 3.25 – 6.68 %. This increase was also reported by Igbabul et al. [22] “for wheat, sweet detar and moringa leaf flour blends cookies”. “They reported that moisture increase in the composite products resulting from

wheat, sweet detar and moringa leaf flour. Bakery products with moisture less than 13% are stable from moisture-dependent deterioration” [19]. The moisture content of all the cookies produced was below this specified moisture content. However, high moisture content in the composite flour cookies is needed for easier mastication, swallowing, refreshing and hydration.

“The ash contents of the cookie samples increased significantly ($P<0.05$) with increased levels of wheat, trifoliate yam and moringa seed flour blends substitution. Ash content gives an insight to the mineral content of food hence, trifoliate yam and moringa seed may be described as a good source of minerals”. Igbabul et al. [22] where a significant ($P<0.05$) increase was observed in the produced cookies. Samia et al. [23], Oyeleke et al. [24], Cláudia et al. [25] and Makanjuola and Makanjuola [26] also reported high ash contents that are similar to this present study. The results obtained in this study are also in agreement with similar reports by Bhosale and Udachan [27], Olorode et al. [28] who also expressed similar ranged of ash contents.

“Crude fibre of the cookies increased significantly from 1.21 – 3.96%, sample F had the highest value (3.96%) while sample A had the lowest value (1.21%). 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” [29]. “The observed increased in fiber was as the result of high fibre content of both trifoliate yam and moringa seed” [24,25,30]. “Fibre consumption has been linked to decreased incidence of heart disease, various types of cancer and diverticulosis” [31]. “Also, high levels of fibre in foods help in digestion of foods and also contribute to the health of the gastrointestinal tract and system in man by aiding normal bowel movement thereby reducing constipation problems which can lead to colon cancer” [32]. “The high fibre contents of the composite cookies suggest that they would be ideal food for people suffering from obesity, diabetes, cancer and gastrointestinal disorders” [33]. According to Schnceman (2002), the crude fibre contributes to the health of the gastrointestinal system and metabolic system in man. Olorode et al. [28] and Bhosale and Udachan [27] reported high fibre contents of wheat-moringa composite cookies. There was an increase in the fat content of the cookies as substitution of wheat flour with

trifoliate yam flour increased. This same trend was also observed by Edima-Nyah and Ukwo [34]; Igbabul et al. [22] who reported an increase in fat content of composite flour blend cookies as the substitution with moringa flour increased. The observed increase maybe due to the contributions of fats from trifoliate yam and moringa seed flours and the fat that was used in baking the cookies [22]. "Fat plays a significant role in predicting the shelf-life of food products and as such, high fat content could be undesirable in baked food products as it promotes rancidity leading to development of unpleasant and odorous compounds" [9].

There was an increase in the protein content of the composite cookies. The protein contents increased from 11.05 to 22.08 %. This increase was significant ($P < 0.05$) for all the cookie samples. This finding is in agreement with that of Edima-Nyah and Ukwo [34] who reported that increase in crude protein of cookies as a result of increase in trifoliate yam proportion. Ayo et al [19] also reported "an increase of wheat-Cardaba flour blend cookies from 12.97-20.97% due to increase in substitution of cardaba banana flour". "The protein plays a part in the organoleptic properties of the cookie samples in addition to being a source of amino acids" [35]. There was a significant decrease ($P < 0.05$) in the carbohydrate content of the cookies supplemented with trifoliate yam and moringa seed flours. The high carbohydrate content in wheat, trifoliate yam and moringa seed flour blend cookies will favour better production of energy in meeting the daily activities. Ijeh et al [36] reported that "high carbohydrate is important as it provides the energy needed to do work; however, low carbohydrate content in diets is also of advantage for diabetic patients that need very low carbohydrate contents in their diets. This indicates the formulated cookie blends will be suitable for diabetic patients, overweight and obese persons".

3.2 Physical Properties of Cookies from Wheat, Trifoliate Yam and Moringa Seed Flour Blends

Table 4 presents the physical properties of cookies products formulated from blends of wheat, trifoliate yam and moringa seed composite flour. There was generally no significant ($p > 0.05$) differences in the physical properties of the formulated cookies from wheat, trifoliate yam and moringa seed composite flour. Diameter, thickness, weight and spread ratio ranged from 4.50-4.90 cm, 0.75-1.30 cm, 10.80-

16.40 g and 3.74-6.78 respectively. As shown in Table 2, the diameter, thickness, weight, spread ratio and break strength did not differ significantly ($P > 0.05$) among samples. The higher diameter values reported for all the cookies samples may be due to increased hydrophilic sites of the starch granules of the non-wheat flours leading to moisture absorption and subsequent diameter increase [22,37]. The decreased thicknesses of the composite cookies from that of control cookies is due to the substitution effects of wheat flour with non-wheat flours (i.e., trifoliate yam starches and *Moringa oleifera* seed flour). Spread ratio is an indication of ability of the cookies to rise, hence the lower the value the better the ability [38].

3.3 Vitamin Content of Cookies from Wheat, Trifoliate Yam and Moringa Seed Flour Blends

Data on the vitamin contents of cookies from wheat, trifoliate yam and moringa seed flour blends are presented in Table 5. The ascorbic acid (vitamin C) and pro-vitamin A increased significantly with increased level of trifoliate yam flour addition while vitamins B₃ and B₆ decreased significantly with increased trifoliate yam flour addition. Differences in vitamin contents of the wheat, trifoliate yam flour and *moringa* seed composite cookies were significant ($P < 0.05$). The vitamin C and pro-vitamin A ranged from 0.57-12.95 mg/100g and 0.26-7.37 µg/100g in 100:0 %:0% which is the control and 45.50: 5 % wheat, trifoliate yam flour and *moringa* seed composite cookies respectively while vitamins B₃ and B₆ showed a decreased range of 0.69-0.38 mg/100g and 0.11-0.06 mg/100g in 100 % wheat, the control and 45.50: 5 % wheat, trifoliate yam flour and *moringa* seed composite cookies respectively.

Vitamins are organic substances required only in small amounts in the body for metabolism. Their requirements are in milligrams (mg), micrograms (µg), milliequivalents (mEq) and international units (IU) [39]. The observed increase in vitamin C and pro-vitamin A in composite cookies was due to the high levels of both vitamins in trifoliate yam and moringa seed [40]. Niacin (vitamin B₃) and pyridoxine (vitamin B₆) decreased in composite cookies due to low values of B₃ and B₆ in both wheat, trifoliate yam and moringa seed. Chukwuka et al. [41] reported low values of niacin (vitamin B₃) in moringa seed and trifoliate yam. Vitamin A is an essential nutrient required for maintaining immune function. It is often known as retinol because it produces the

pigment in the retina of the eye [5]. Vitamin A refers to pro-vitamin A carotenoids and the preformed retinols, plus their metabolites. A deficiency of vitamin A constitutes one of the major public health problems in developing countries. Vitamin A deficiency is the leading cause of non-accidental blindness. Children from impoverished Nations are especially susceptible because their inadequate intake and diminished stores of vitamin A fail to meet the increased needs associated with rapid growth [42]. Vitamin C is needed in the body for the synthesis of collagen, an intracellular cement substance which binds animal cells together. The presence of vitamin C is required to maintain the structure and integrity of bone matrix, cartilage, connective tissues, blood vessels, gums and skin. Its deficiency results in scurvy and also characterized by fragile, easily ruptured capillaries with consequent tissue bleeding and it is needed for wound healing [39].

3.4 Mineral Content of Cookies from Wheat, Trifoliolate Yam and Moringa Seed Flour Blends

Presented in Table 6 are data on the mineral content of cookies from wheat, trifoliolate yam and moringa seed flour blends. Generally, the differences in the results of the mineral parameters of all the cookies samples were significant ($P < 0.05$). The results also showed increased values of the mineral contents with increased level of trifoliolate yam flour substitution. The magnesium (Mg), calcium (Ca), potassium (K) and iron (Fe) ranged from 143.00-182.50 mg/100g, 252.60-342.60 mg/100g, 26.55-36.25 mg/100g and 21.55-48.36 mg/100g respectively.

Minerals are inorganic elements which are essential for the normal functioning of the body. They are required in smaller quantities in addition

Table 3. Proximate Composition of cookies from wheat, trifoliolate yam and moringa seed flour blends

Samples	Moisture %	Ash %	Fiber (%)	Fat %	Protein %	Carbohydrate %
A	3.25 ^f ±0.05	2.33 ^d ±0.04	1.21 ^f ±0.06	19.10 ^e ±0.14	11.05 ^f ±0.02	63.09 ^a ±0.08
B	4.28 ^e ±0.03	2.36 ^d ±0.06	1.71 ^e ±0.03	19.20 ^e ±0.06	12.24 ^e ±0.06	60.26 ^a ±0.06
C	5.33 ^d ±0.04	2.33 ^d ±0.04	2.07 ^d ±0.05	21.10 ^d ±0.11	13.27 ^d ±0.05	55.90 ^a ±0.21
D	5.64 ^c ±0.05	3.57 ^c ±0.10	2.82 ^c ±0.05	21.50 ^c ±0.04	15.52 ^c ±0.04	45.94 ^b ±6.97
E	5.89 ^b ±0.01	4.90 ^b ±0.08	3.39 ^b ±0.09	22.40 ^b ±0.04	19.76 ^b ±0.13	43.64 ^b ±0.07
F	6.68 ^a ±0.03	5.72 ^a ±0.05	3.96 ^a ±0.03	22.83 ^a ±0.06	22.08 ^a ±0.04	38.75 ^b ±0.05

Values are means± standard deviation of duplicate determination. Means in the same column with different superscripts are significantly ($P < 0.05$) different

Key

A (control) = 100 % wheat flour + 0% trifoliolate yam flour + 0% Moringa seed flour

B = 85 % wheat flour + 10% trifoliolate yam flour + 5 % Moringa seed flour

C = 75 % wheat flour + 20% trifoliolate yam flour + 5 % Moringa seed flour

D = 65 % wheat flour + 30 % trifoliolate yam flour + 5 % Moringa seed flour

E = 55 % wheat flour + 40 % trifoliolate yam flour + 5 % Moringa seed flour

F = 45 % wheat flour + 50 % trifoliolate yam flour + 5 % Moringa seed flour

Table 4. Physical Properties of Cookies from wheat, trifoliolate yam and moringa seed flour blends

Samples	Diameter (cm)	Thickness (cm)	Weight (g)	Spread ratio
A	4.50 ^a ±0.28	1.30 ^a ±0.00	10.80 ^b ±0.14	4.00 ^b ±0.24
B	4.65 ^a ±0.21	1.20 ^{ab} ±0.00	14.20 ^{ab} ±2.41	3.74 ^b ±0.16
C	4.75 ^a ±0.07	1.20 ^{ab} ±0.00	14.65 ^{ab} ±2.19	4.13 ^b ±0.06
D	4.80 ^a ±0.42	1.10 ^{ab} ±0.00	13.95 ^{ab} ±2.19	3.92 ^b ±0.36
E	4.85 ^a ±0.28	1.05 ^b ±0.07	13.55 ^{ab} ±2.47	4.18 ^b ±0.01
F	4.90 ^a ±0.14	0.75 ^c ±0.21	16.40 ^a ±0.42	6.78 ^a ±1.73

Values are means± standard deviation of duplicate determination. Means in the same column with different superscripts are significantly ($P < 0.05$) different

Key

A (control) = 100 % wheat flour + 0% trifoliolate yam flour + 0% Moringa seed flour

B = 85 % wheat flour + 10% trifoliolate yam flour + 5 % Moringa seed flour

C = 75 % wheat flour + 20% trifoliolate yam flour + 5 % Moringa seed flour

D = 65 % wheat flour + 30 % trifoliolate yam flour + 5 % Moringa seed flour

E = 55 % wheat flour + 40 % trifoliolate yam flour + 5 % Moringa seed flour

F = 45 % wheat flour + 50 % trifoliolate yam flour + 5 % Moringa seed flour

Table 5. Vitamin content of cookies from wheat, trifoliolate yam and moringa seed flour blends

Sample	Ascorbic Acid (Vitamin C)	β -Carotene(Pro-Vitamin A) ($\mu\text{g}/100\text{g}$)	Niacin (Vitamin B ₃)	Pyridoxine (Vitamin B ₆)
A	0.57 ^a ±0.02	0.26 ^a ±0.04	0.69 ^a ±0.00	0.11 ^f ±0.00
B	9.39 ^b ±0.06	5.47 ^b ±0.16	0.45 ^b ±0.00	0.10 ^e ±0.00
C	9.73 ^c ±0.04	5.91 ^c ±0.00	0.44 ^c ±0.01	0.08 ^d ±0.00
D	10.31 ^d ±0.02	6.34 ^d ±0.25	0.43 ^d ±0.00	0.07 ^c ±0.00
E	11.91 ^e ±0.04	6.49 ^d ±0.03	0.39 ^e ±0.01	0.07 ^b ±0.00
F	12.95 ^f ±0.01	7.37 ^e ±0.04	0.38 ^f ±0.00	0.06 ^a ±0.00

Values are means± standard deviation of duplicate determination. Means in the same column with different superscripts are significantly ($P<0.05$) different

Key

A (control) = 100 % wheat flour + 0% trifoliolate yam flour + 0% Moringa seed flour

B = 85 % wheat flour + 10% trifoliolate yam flour + 5 % Moringa seed flour

C = 75 % wheat flour + 20% trifoliolate yam flour + 5 % Moringa seed flour

D = 65 % wheat flour + 30 % trifoliolate yam flour + 5 % Moringa seed flour

E = 55 % wheat flour + 40 % trifoliolate yam flour + 5 % Moringa seed flour

F = 45 % wheat flour + 50 % trifoliolate yam flour + 5 % Moringa seed flour

to proteins, carbohydrates, fats and vitamins, they are inorganic or “ash constituents” of foods which cannot be destroyed by heating [39]. Although they yield no energy, they have important roles to play in many activities in the body [9]. As ash content gives an insight to the mineral content of the food, hence, cookies produced from wheat, trifoliolate flour and moringa seed composite flour can be described as a rich source of minerals as seen from the significant ($P<0.05$) increase in the mineral contents of cookies with increased levels of trifoliolate yam flour addition. All the cookies samples appeared to be good source of magnesium, calcium, potassium and iron.

The increase in magnesium content of composite cookies may largely be a pointer to the fact that trifoliolate yam flour is a rich source of magnesium. Magnesium in the diet and cell catalyzes hundreds of metabolic reactions resulting in changes in energy status, catalyzes the oxidative phosphorylation on adenosine diphosphate (ADP), and adenosine triphosphate (ATP). Also, the release of energy which results when ATP is converted to ADP requires magnesium [39]. Calcium is a mineral required by the body for a variety of physiological functions and the maintenance of bone tissues throughout life (Grosvernor and Smolin, 2002).

Calcium is necessary for supporting bone formation and growth; it also helps in the maintenance of healthy teeth, skeletal and soft tissue, mucous membranes and skin. As an essential nutrient for human health, Iron also plays an important role in normal growth and development [43]. Potassium activates several enzyme reactions and helps in the release of

energy from carbohydrates, fats and proteins. It also functions with sodium and calcium to regulate neuromuscular excitability [39]. Adesuyi and Ipinmoroti [30], Samia et al. [23], Chukwuka et al. [41] and Kadiri [40] revealed significant presence of mineral elements such as calcium, potassium, sodium and phosphorus in trifoliolate yam.

3.6 Sensory Properties of Cookies from Wheat, Trifoliolate Yam and Moringa Seed Flour Blends

Data on the sensory attributes of cookies from wheat, trifoliolate yam and moringa seed flour blends are presented in Table 7. Generally, the cookies samples showed decreased values in all the sensory parameters with increased level of trifoliolate yam flour addition. The appearance, flavor, taste, mouth feel and overall acceptability ranged from 8.40-4.60, 8.55-5.35, 8.40-4.35, 8.10-5.75 and 8.25-5.10 in the 100 % wheat cookies which is the control and 45:50: 5 % wheat, trifoliolate and moringa seed composite cookies respectively.

Sensory evaluation is usually carried out towards the end of product development or formulation cycle and this is done to assess the reactions of consumers/judges about the product to determine the acceptability of such product. It is an important criterion for assessing quality in the development of new products and for meeting consumer requirements [44].

Appearance is an important sensory attribute of any food because of its influence on acceptability. The brown colour resulting from

Table 6. Mineral content of cookies from wheat, trifoliolate yam and moringa seed flour blends

Samples	Magnesium (Mg)	Calcium (Ca)	Potassium (K)	Iron (Fe)
A	143.00 ^a ±0.85	252.60 ^a ±0.28	26.55 ^a ±0.21	21.55 ^a ±0.21
B	157.50 ^b ±0.42	269.40 ^b ±0.35	28.10 ^b ±0.00	33.48 ^b ±0.33
C	161.60 ^c ±0.21	273.50 ^c ±0.50	28.55 ^{bc} ±0.07	35.66 ^c ±0.06
D	173.30 ^d ±0.28	275.50 ^d ±0.50	28.95 ^c ±0.07	39.50 ^d ±0.42
E	178.70 ^e ±0.35	290.40 ^e ±0.21	30.45 ^d ±0.21	42.07 ^e ±0.06
F	182.50 ^f ±0.28	342.60 ^f ±0.35	36.25 ^e ±0.35	48.36 ^f ±0.08

Values are means± standard deviation of duplicate determination. Means in the same column with different superscripts are significantly ($P<0.05$) different

Key

A (control) = 100 % wheat flour + 0% trifoliolate yam flour + 0% Moringa seed flour

B = 85 % wheat flour + 10% trifoliolate yam flour + 5 % Moringa seed flour

C = 75 % wheat flour + 20% trifoliolate yam flour + 5 % Moringa seed flour

D = 65 % wheat flour + 30 % trifoliolate yam flour + 5 % Moringa seed flour

E = 55 % wheat flour + 40 % trifoliolate yam flour + 5 % Moringa seed flour

F = 45 % wheat flour + 50 % trifoliolate yam flour + 5 % Moringa seed flour

Table 7. Sensory Properties of Cookies from Wheat, Trifoliolate Yam and Moringa Seed Flour Blends

Samples	Appearance	Flavor	Taste	Mouth Feel	Overall Acceptability
A	8.40 ^a ±0.68	8.55 ^a ±0.51	8.40 ^a ±0.60	8.10 ^a ±0.72	8.25 ^a ±0.72
B	7.85 ^b ±0.81	7.70 ^b ±0.80	8.00 ^a ±0.65	7.10 ^b ±0.72	7.60 ^b ±0.94
C	7.45 ^b ±0.60	6.80 ^c ±1.11	7.90 ^a ±0.72	6.85 ^{bc} ±0.93	7.25 ^b ±0.97
D	6.75 ^c ±0.79	5.95 ^d ±1.05	6.85 ^b ±0.93	6.40 ^{cd} ±1.39	6.05 ^c ±1.10
E	5.15 ^d ±0.75	5.55 ^d ±1.28	6.30 ^b ±1.22	6.35 ^{cd} ±1.31	5.90 ^c ±1.07
F	4.60 ^e ±0.82	5.35 ^d ±1.23	4.35 ^c ±1.14	5.75 ^d ±1.25	5.10 ^d ±0.97

Values are means± standard deviation of duplicate determination. Means in the same column with different superscripts are significantly ($P<0.05$) different

Key

A (control) = 100 % wheat flour + 0% trifoliolate yam flour + 0% Moringa seed flour

B = 85 % wheat flour + 10% trifoliolate yam flour + 5 % Moringa seed flour

C = 75 % wheat flour + 20% trifoliolate yam flour + 5 % Moringa seed flour

D = 65 % wheat flour + 30 % trifoliolate yam flour + 5 % Moringa seed flour

E = 55 % wheat flour + 40 % trifoliolate yam flour + 5 % Moringa seed flour

F = 45 % wheat flour + 50 % trifoliolate yam flour + 5 % Moringa seed flour

Maillard reaction is always associated with baked goods. The study showed significant decrease in the appearance of the cookies samples with increased trifoliolate yam flour substitution. This is due to the darkish nature of trifoliolate yam. According to Sudha et al. [45], progressive increase in supplementation with non-wheat flour, appearance turns towards darker leading to lower acceptability. Appearance change also, might be due to caramelization, dextrinization of starch or Maillard reaction involving the interaction of reducing sugar or proteins [46]. Ubbor and Akobundu [47] and Sengev et al. [48] reported similar darkish nature of cookies on supplementation of wheat flour with watermelon seed-cassava composite flour and *Moringa oleifera* leaf powder respectively. Taste is a sensory parameter that affects the quality and acceptability of food products. No matter how rich or nutritious a food is, if it tastes bad, such food would not be accepted by people. Taste is the primary factor determining the acceptability of any product and has the highest impact in

determining the market success of product. The taste scores showed decreased values with increased trifoliolate yam flour addition. This might be due to the bitter nature of the trifoliolate yam. Flavor is another attribute that influences the acceptability of baked good products even before they are tasted. From the result of the sensory attributes of cookies, there is decreasing trend in the mean score of flavor as the level of supplementation increased downwards. The results are consistent with those observed in earlier studies by Mian et al. [49] and Mepba et al., [50] in which wheat flour was supplemented with defatted rice bran and plantain respectively in cookies production. Similar, decreased trend was observed for mouth feel as the level of trifoliolate yam flour addition increased. Overall acceptability was determined on the basis of quality scores obtained from evaluation of appearance, taste, flavor and mouth feel. The decrease in the general acceptability of composite cookies in this study was reported in another study on wheat/yam composite cookies

by Amandikwa et al. [51]. Mepba et al. [50] and Joseph et al. [52] reported similar decreased values of overall acceptability of wheat-based cookies supplemented with plantain and ripe banana slices flours respectively.

4. CONCLUSION AND RECOMMENDATIONS

The nutritional and sensory qualities of cookies from wheat, trifoliolate yam and moringa seed flour was investigated and the following conclusions were drawn.

The addition of trifoliolate yam and *Moringa* seed flour to wheat in cookies formulation significantly increased the moisture, ash, crude fibre, crude fat and protein contents of wheat-based cookies but with a decreased carbohydrate contents as the level of trifoliolate yam flour addition increased.

The result of the physical properties showed no significant ($P>0.05$) difference for diameter (cm) of the cookies. However, a significant ($P<0.05$) difference was observed for thickness, weight and spread ratio. The minerals and vitamins contents such as magnesium, calcium, potassium and iron, ascorbic acid (vitamin C) and β -carotene (pro-vitamin A) increased while the niacin (vitamin B₃) and pyridoxine (B₆) decreased as the level of trifoliolate yam flour addition increased.

Sensory attributes of this study showed that the trifoliolate yam flour could be incorporated up to the levels of 10 and 20 % in the wheat and moringa flour without greatly influencing the organoleptic characteristics of the cookies. Though the cookies made from 100 % wheat is the most preferred, the cookies supplemented with up to 10 % trifoliolate yam and 5% moringa seed flour was also highly acceptable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- Makinde FM, Adeyemi AT. Quality Characteristics of Biscuits Produced from Composite Flours of Wheat, Corn, Almond and Coconut. *Annals of Food Science and Technology*, 2018;19(2): 216-225.
- Okafor GI, Ugwu FC. Production and evaluation of cold extruded and baked ready-to-eat snacks from blends of breadfruit (*Treculia africana*), cashewnut (*Anacardium occidentale*) and coconut (*Cocos nucifera*). *Food Science and Quality Management*. 2014;23:65-77.
- Farheena I, Avanish K, Uzma A. Development and Quality Evaluation of Cookies Fortified with Date Paste (*Phoenix dactylifera* L). *International Journal of Science and Technology* 2015;3(4).
- Ajibola FC, Oyerinde OV, Adeniyani SO. Physicochemical and antioxidant properties of whole wheat biscuits incorporated with Moringa oleifera leaves and cocoa powder. *Journal of scientific research and report*. 2015;7(3):195 – 206.
- Chinma CE, Gernah DI. Physicochemical and Sensory Properties of Cookies From Cassava, Soybean, and Mango Composite Flour. *Journal of Food Technology*. 2007;5(3):256-260.
- Uthumporn U, Woo WL, Tajul AY, Fazilah A. Physico-chemical and nutritional evaluation of cookies with different levels of eggplant flour substitution. *Journal of Food*. 2014;13(2):220–226.
- Amandikwa C. Proximate and Functional Properties of Open Air, Solar and Oven Dried Cocoyam Flour. *International Journal of Agriculture and Rural Development*. 2012;15(2): 988-994.
- Jideani IA, VA Jideani. Developments on the cereal grains *Digitaria exilis* (acha) and *Digitaria iburua* (iburu). *J. Food Sci. Technol*. 2011;48:251-259.
- Ihekoronye AI, Ngoddy PO. *Integrated Food Science and Technology for the Tropics*. London: Macmillan Publ. Ltd. 1985;265.
- Chen WJ, Anderson JW. Hypocholesterolemic effects of soluble fibers. In *Dietary fiber: basic and clinical aspects* 1986 (pp. 275-286). Boston, MA: Springer US.
- Abiodun OA, Akinoso R, Oladapo AS, Adepeju AB. Influence of soaking method on the chemical and functional properties of trifoliolate yam (*Dioscorea dumetorum*) flours. *J Root Crop* 2013;39:81-87.
- Akinoso R, Olatoye KK, Ogunyele OO. Potentials of trifoliolate yam (*Dioscorea dumetorum*) in noodles production. *J Food Process Technol*. 2016;7(609):1-6.
- Sharma V, Paliwal R, Pracheta and Sharma S. Phytochemical analysis and evaluation of antioxidant activities of hydro-ethanolic extract of *Moringa oleifera* Lam. Pods. *J. Pharm. Res.*, 2011;4:554-557.

14. Khalafalla M, Abdellatef E. Active principle from *Moringa oleifera* Lam leaves effective against two leukemias and a hepatocarcinoma. African J. of Biotechnology. 2010;9(49):8467–8471.
15. Agbogidi OM, Ilondu EM. Moringa oleifera Lam: Its potentials as a food security and rural medicinal item; 2012.
16. Khalaf DJ, Annala M, Taavitsainen S, Finch DL, Oja C, Vergidis J, Chi KN. Optimal sequencing of enzalutamide and abiraterone acetate plus prednisone in metastatic castration-resistant prostate cancer: a multicentre, randomised, open-label, phase 2, crossover trial. The Lancet Oncology. 2019;20(12):1730-1739.
17. Chinma CE, Igbabul BD, Omotayo OO. Quality characteristics of cookies prepared from unripe plantain and defatted sesame flour blends. American Journal of Food Technology. 2012;7:398 – 408.
18. AOAC. Official Methods of Analysis of AOAC International. 19th edition. AOAC International, Gaithersburg, Maryland, USA; 2012.
19. Ayo-Omogie HN, Odekunle OY. Substituting wheat flour with banana flour: Effects on the quality attributes of doughnut and cookies. Applied Tropical Agriculture. 2017;22(2):134-137.
20. AACCC. Approved Methods of the American Association of Cereal Chemists. 10th Edn., American Association of Cereal Chemists Press, St. Paul, MN., USA; 2000.
21. Okaka JC. Handling, Storage and Processing of Plant Foods. 2nd Edn., Academy Publishers Enugu, Nigeria. 2009:132.
22. Igbabul B, Ogunrinde MD, Amove J. Proximate, micronutrient composition, physical and sensory properties of cookies produced with wheat, sweet detar and moringa leaf flour blends. Current Research in Nutrition and Food Science Journal. 2018;6(3):690-699.
23. Samia O, Hanan R, Kamal ET. Carbamazepine muco adhesive nanoemulgel (MNEG) as brain targeting delivery system via the olfactory mucosa. Drug delivery, 2012;19(1):58-67.
24. Oyeleke GO, Ojo A, Ajao FD, Adetoro RO. Development and analysis of blended pineapple-watermelon ready-to-drink (RTD) juice. Journal of Environmental Science, Toxicology and Food Technology. 2013;4(6):22-24.
25. Cláudia AR, Figueroa AM, Los PR, Teles JC, Simões DRS, Barana AC, Granato D. Effects of whole-wheat flour and bordeaux grape pomace (*Vitis labrusca* L.) on the sensory, physicochemical and functional properties of cookies. Food Science and Technology. 2014;35:750-756.
26. Makanjuola OM, Makanjuola JO. Proximate and selected mineral composition of ripe pawpaw (*Carica papaya*) seeds and skin. Journal of Scientific and Innovative Research. 2018: 7(3):75-77.
27. Bhosale P, Udachan IS. Studies on utilization of papaya peel and seed powder for development of fiber enriched functional cookies. IJRAR-International Journal of Research and Analytical Reviews (IJRAR), 2018;5(4):459-466.
28. Olorode OM, Akkutlu IY, Efendiev Y. Compositional reservoir-flow simulation for organic-rich gas shale. SPE Journal, 2017; 22(06):1963-1983.
29. Odenigbo UM. Incorporation of afzelia africana [akparata] in dietary managements of type 2 diabetes mellitus in Nnewi, Nigeria. D Thesis; 2001.
30. Adesuyi AO, Ipinmoroti KO. The Nutritional and Functional Properties of the Seed Flours of three Varieties of *Carica Papaya*. Current Research in Chemistry. 2011;3:70-75.
31. Wildman SA. Prediction of physicochemical parameters by atomic contributions. Journal of chemical information and computer sciences, 1999; 39(5):868-873.
32. Schneeman BO. Gastrointestinal physiology and functions. British Journal of Nutrition. 2002;88(S2):S159-S163.
33. Ufot EI, Comfort FE, Anne PE. Physical Properties, Nutritional Composition and Sensory Evaluation of Cookies Prepared from Rice, Unripe Banana and Sprouted Soybean Flour Blends. International Journal of Food Science and Biotechnology. 2018;3(2):70-76.
34. Ukwo S, Edima-Nyah A. Micronutrients and heavy metals content of refined and local table salts consumed in some Nigerian cities. Am. J. innov. res. appl. Sci. 2016;2(4):193-198.
35. Usman M, Daud WW, Abbas HF. Dry reforming of methane: Influence of process parameters—A review. Renewable and Sustainable Energy Reviews, 2015;45:710-744.
36. Ijeh I, Ejike CE, Nkwonta OM, Njoku BC. Effect of traditional processing techniques on the nutritional and phytochemical

- composition of African bread-fruit (*Treculia africana*) seeds. *Journal of Applied Sciences and Environmental Management*, 2010;14(4).
37. Opara UL. A review on the role of packaging in securing food system: Adding value to food products and reducing losses and waste. *African Journal of Agricultural Research*, 2013;8(22): 2621-2630.
 38. Ahmad S, Ullah F, Sadiq A, Ayaz M, Imran M, Ali I, Shah MR. Chemical composition, antioxidant and anticholinesterase potentials of essential oil of *Rumex hastatus* D. Don collected from the North West of Pakistan. *BMC complementary and alternative medicine*, 2016;16:1-11.
 39. Chidinma WA, Jiddari WU, Hassan SC. A student handbook on food and nutrition. De-New Creation Prints Ltd Publishers, Kaduna, Nigeria. 2010:50-58.
 40. Kadiri O. A review on the status of the phenolic compounds and antioxidant capacity of the flour: Effects of cereal processing. *International Journal of Food Properties*, 2015;20(1):S798-S809.
 41. Chukwuka KS, Iwuagwu M, Uka UN. Evaluation of nutritional components of *Carica papaya* L. at different stages of ripening. *IOSR Journal of Pharmacy and Biological Sciences*. 2013;6(4): 13-16.
 42. Wardlaw GM, Kessel MW. Minerals: Dietary needs, absorption, transport and excretion. *Perspectives in nutrition*, 5th edn. Mc Graw-Hill Companies Inc. 2002;418-464.
 43. Inyang UE, Ekop VO. Physico-chemical properties and anti-nutrient contents of unripe banana and African yam bean flour blends. *International Journal of Food Sciences and Nutrition*. 2015;4(5):549-554.
 44. Dogo EM, Afolabi OJ, Nwulu NI, Twala B, Aigbavboa CO. A comparative analysis of gradient descent-based optimization algorithms on convolutional neural networks. In 2018 international conference on computational techniques, electronics and mechanical systems (CTEMS) December 2018;92-99. IEEE.
 45. Sudha ML, Vetrmani R, Leelavathi K. Influence of fibre from different cereals on the rheological characteristics of wheat flour dough and on biscuit quality. *Food chemistry*. 2007;100(4):1365-1370.
 46. Manley PW, Cowan-Jacob SW, Buchdunger E, Fabbro D, Fendrich G, Furet P, Zimmermann J. Imatinib: a selective tyrosine kinase inhibitor. *European journal of cancer*, 2002;38:S19-S27.
 47. Ubbor SC, Akobundu ENT. Quality characteristics of cookies from composite flours of watermelon seed, cassava and wheat. *Pakistan Journal of Nutrition*, 2009;8(7):1097-1102.
 48. Sengevi AI, Abu JO, Gernah DI. Effect of *Moringa oleifera* leaf powder supplementation on some quality characteristics of wheat bread. *Food and nutrition sciences*, 2013;4(3):270.
 49. Mian SI, Li AY, Dutta S, Musch DC, Shtein RM. Dry eyes and corneal sensation after laser in situ keratomileusis with femtosecond laser flap creation: Effect of hinge position, hinge angle, and flap thickness. *Journal of Cataract & Refractive Surgery*. 2009;35(12):2092-2098.
 50. Mepba HD, Eboh L, Nwaojigwa SU. Chemical composition, functional and baking properties of wheat-plantain composite flours. *African Journal of food, agriculture, nutrition and development*. 2007;7(1).
 51. Amandikwa C, Iwe MO, Uzomah A. Physico-chemical Properties of Wheat-yam Flour Composite Bread. *Nigerian Food Journal*, 2015;33(1):12-17.
 52. Joseph RY, Casteleijn D, van der Linde J, Franzsen D. Sensory modulation dysfunction in child victims of trauma: A scoping review. *Journal of Child & Adolescent Trauma*, 2016;1-16.

© 2023 Fayomi et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<https://www.sdiarticle5.com/review-history/108003>