Original Research Article

NUTRITIONAL AND SENSORY QUALITIES OF COOKIES FROM WHEAT, TRIFOLIATE YAM AND MORINGA SEED FLOURS

ABSTRACT

Nutritional and sensory qualities of cookies from wheat, trifoliate yam and moringa seed flourwere 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 β-carotene (pro-vitamin A) increased while the niacin (vitamin $B_{3)}$ and pyrodixine (B_6) decreased as the level of trifoliate yam flour addition increased. Sensory attributes of this study showed that the trifoliate 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. Trifoliate 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. Trifoliate 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, Trifoliate yam, Proximate, Mineral and 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 (Makinde and Adeyemi, 2018). In recent times, snack products are increasingly gaining global acceptance due to job demands, convenience driven lifestyles and dietary habits (Okafor and Ugwu, 2014). 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 (Farheena*et al.,* 2015). 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 (Ajibola *et al.,* 2015). Also, cookies can therefore serve as a vehicle for delivering important nutrients if made readily available to the population (Chinma and Gernah, 2007). Uthumporn*et al.* (2014) 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 (Farheena*et al.*, 2015). They can be made from hard dough, hard sweet dough or soft dough. (Nwosu, 2013, Farheena*et al.*, 2015). 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 (Ajibola *et al.*, 2015).

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 (Ihekonroye and Ngoddy, 1985). 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 (Chen and Anderson, 1986). Trifoliate 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 (Abiodun *et al.*, 2013). It has starch grains that are smaller, more digestible than those of other yam species. Trifoliate 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 (Akinoso*et al.*, 2016). 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 (Sharma *et al.*, 2011). It is considered one of the most useful tree in the world because almost all parts of this plant can be used as food (Khalafalla and Abdel-latef, 2010). In numerous parts of the world including Africa, the utilization of *M*oringa *oleifera* as a food fortificant is on the increases (Agbogidi and Ilondu, 2012).

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 ^{o}C for 10 min and dried in the hot air oven (LCI/12H/GLAD/ING) at 80 ^{o}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 (Abiodun *et al.*, 2013) as shown in Chart 1

Trifoliate yam tubers
↓
Cleaning and sorting
↓
Peeling (Knife)
↓
Weighing (2000 g)
↓
Washing (Manually)
↓
Slicing (Knife)
↓
Soaking (12 hrs)
↓
Blanching (60°C for 10 min)
↓
Draining/cooling (20 min)
↓
Oven Drying (80°C for 72 hrs)
↓
Milling (hammer mill)
↓
Cooling
↓
Sieving (250 µm)
↓
Packaging

Chart 1: Production of Trifoliate Yam Flour

Source: Abiodun *et al.* (2013)

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

Moringa seeds
↓
Dehulling
↓
Debittering (boiling 35 min)
↓
Oven drying (80 °C 8 h)
↓
Defatting (screw press)
↓
Weighing (1000 g)
↓
Milling
↓
Sieving
↓
Moringa seed flour
↓
Packaging

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

Source: Khalaf *et al.,* 2019

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

The wheat, trifoliate yam and *Moringa* seed flourswere used for the formulation of cookies and mixed in different proportions. Sample A was made up of 100% wheat flour 0% Trifoliate 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% Trifoliate yam flour, and 5% Moringa seed flour (85:10:5), sample C was comprise of 75% wheat flour,20% Trifoliate yam flour and 5% moringa seed flour (75:20:5), sample D was ,60% wheat flour, 30% Trifoliate yam flour and 5% moringa seed flour (60:30:5) ,sample E will be comprise of 55% wheat flour,40% Trifoliate yam flour and 5% moringa seed flour (55:40:5) and finally sample F were comprise of 45% wheat flour,50%l Trifoliate yam flour and 5% moringa seed flour (45:50:5).The different wheat flour, trifoliate yam and moringa seed flour formulated for the cookies as shown in the Table 1.

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

Cookies were prepared according to the method of (Chinma*et al.*, 2012) 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 3minutes. 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^{0}C for 10 mins in the baking oven. Following baking, the cookies were allowed to cool at ambient temperature, packed and stored at 23^0 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 (%)	Trifoliate 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% trifoliate yam flour + 0% Moringa seed flour
B = 85 % wheat flour + 10% trifoliate yam flour + 5 % Moringa seed flour
C = 75 % wheat flour + 20% trifoliate yam flour + 5 % Moringa seed flour
D = 65 % wheat flour + 30 % trifoliate yam flour + 5 % Moringa seed flour
E = 55 % wheat flour + 40 % trifoliate yam flour + 5 % Moringa seed flour
F = 45 % wheat flour + 50 % trifoliate yam flour + 5 % Moringa seed flour

Table 2:Recipes for Blends of Wheat, Trifoliate Yam and Moringa Seed Flours

Sample code	Wheat Flour (g)	Trifoliate 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% trifoliate yam flour + 0% Moringa seed flour
B = 85 % wheat flour + 10% trifoliate yam flour + 5 % Moringa seed flour
C = 75 % wheat flour + 20% trifoliate yam flour + 5 % Moringa seed flour
D = 65 % wheat flour + 30 % trifoliate yam flour + 5 % Moringa seed flour
E = 55 % wheat flour + 40 % trifoliate yam flour + 5 % Moringa seed flour
F = 45 % wheat flour + 50 % trifoliate yam flour + 5 % Moringa seed flour

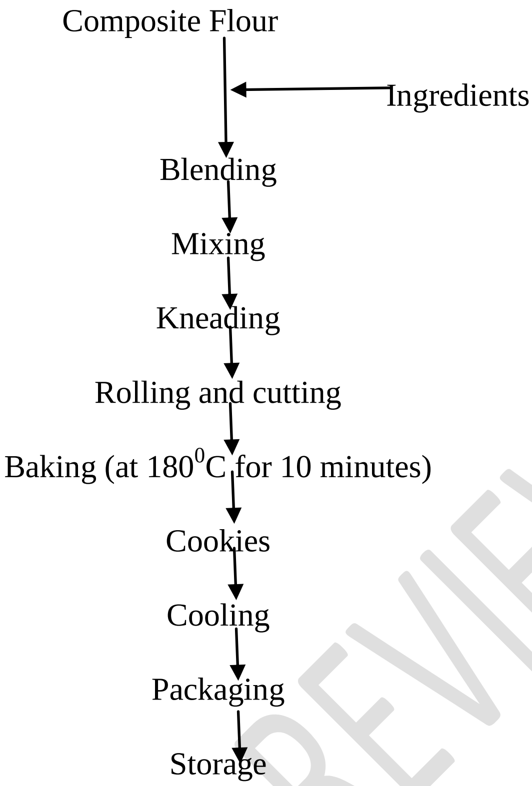

Chart 3 : Flow Chart Showing the Production of Cookies
Source: Chinma*et al.* (2012) Modified

2.5 Determination of Proximate Composition of Cookies

The proximate composition of the cookies flour was determined using the methods of AOAC (2015) and Carbohydrate content was determined by difference according to Ihekoronye and Ngoddy (1985).

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.

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

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:

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

Where, S = sample titre, B = Blank titre, S - B = Corrected titre, D = Diluted factor
% Crude Protein = % Nitrogenx 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 ^{o}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

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

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^{o}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^{o}C for 30 min, cooled and weighed. The percentage crude fibre content was calculated as:

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

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.

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

Where:
W1 = Weight of empty crucible,
W_2 = Weight of crucible + sample before ashing,
W_3 = Weight of crucible + content after ashing.

2.5.6 Carbohydrate determination

Carbohydrate content was determined by difference according to Ihekoronye and Ngoddy (1985) as follows:

$$\% \, Carbohydrate = 100 - (\% \, moisture + \% \, protein + \% fat + \% ash + \% fibre)$$

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.*, (2007). 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 (2000). 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*. (2007). 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 (1990). The diameter and thickness of the unbaked cut out dough and baked dough was measured using the venier caliper.

$$Spread\ ratio = \frac{baked\ cookies\ diameter - unbaked\ cookies\ diameter}{baked\ cookies\ thickness - unbaked\ cookies\ thickness}$$

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

2.7.1 Determination of iron

Standard solution containing 100 mg/mL of Fe^{3+} 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 (UniscopeSurgifriends 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 (AOAC, 2012). One gram (1 g) 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 Mg^{2+} 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 (AOAC, 2012). One (1) gram of sample was dissolved in 20 mL of acid mixture (650 mL of concentrated HNO_3; 80 mL PCA; 20 mL conc. H_2SO_4) 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 Ca^{2+} 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 (UniscopeSurgifriends, 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 (2012) 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 H_2O. The extract was filtered through filter paper containing 5 g anhydrous Na_2SO_4 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 $SbCl_3$ 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 B_3

These were determined using the method described by AOAC, (2012). 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 ^{0}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 ^{0}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 B_9)

Folic acid (vitamin B_9) was determined by microbiological assay according to AOAC (2012).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 ^{0}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 ^{0}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 ^{0}C.

2.9.4 Determination of vitamin B_{12}

Vitamin B_{12} 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^{0}C, 5000 rpm for 15 min. The supernatant was filtered through a 0.2 µm nylon filter. After flowing the standard 5% methanol in H_2O 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 H_2O 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 H_2O to eliminate the residual moisture. Finally, the vitamin B_{12} was eluted with 5 mL of methanol. The sample eluate was concentrated with nitrogen gas and then re dissolved in 1 mL of H_2O 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 (Ihekoronye and Ngoddy, 1985). A panel of fifteen members consisting of students and members of staff in Food Science and Technology Department, Joseph SarwuanTarkaa 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 flourcomposite 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*. (2018) 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 (Ayo-Omogie and Odekunle, 2017). 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. This result is similar to that reported by Igbabul*et al*. (2018) where a significant (P<0.05) increase was observed in the produced cookies. Samia *et al.* (2012), Oyeleke *et al.* (2013), Cláudia *et al.* (2014) and Makanjuola and Makanjuola(2018) alsoreported high ash contents that are similalr to this present study. The results obtained in this study are also in agreement with similar reports by Bhosale and Udachan (2018), Olorode*et al.* (2017) 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 (Odenigbo, 2001). The observed increased in fiber was as the result of high fibre content of both trifoliate yam and moringa seed (Oyeleke *et al*., 2013; Cláudia *et al*., 2014 and Adesuyi and Ipinmoroti, 2011). Fibre consumption has been linked to decreased incidence of heart disease, various types of cancer and diverticulosis (Wildman, 1999). 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 (Schneeman, 2002). 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 (Ufot*et al.*, 2018).According to Schnceman(2002), the crude fibre contributes to the health of the gastrointestinal system and metabolic system in man. Olorode*et al.* (2017) and Bhosale and Udachan (2018) 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 (2016); Igbabul*et al*. (2018) 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 (Igbabul*et al*., 2018). 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 (Ihekoronye and Ngoddy, 1985).

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 (2016) who reported that increase in crude protein of cookies as a result of increase in trifoliate yam proportion. Ayo *et al* (2015) 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 (Usman, *et al*, 2015).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* (2010) 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.

Table 3: Proximate Composition of cookies from wheat, trifoliate yam and moringa seed flour blends

Samples	Moisture %	Ash %	Fiber (%)	Fat %	Protein %	Carbohydrate %
A	$3.25^{f}\pm0.05$	$2.33^{d}\pm0.04$	$1.21^{f}\pm0.06$	$19.10^{e}\pm0.14$	$11.05^{f}\pm0.02$	$63.09^{a}\pm0.08$
B	$4.28^{e}\pm0.03$	$2.36^{d}\pm0.06$	$1.71^{e}\pm0.03$	$19.20^{e}\pm0.06$	$12.24^{e}\pm0.06$	$60.26^{a}\pm0.06$
C	$5.33^{d}\pm0.04$	$2.33^{d}\pm0.04$	$2.07^{d}\pm0.05$	$21.10^{d}\pm0.11$	$13.27^{d}\pm0.05$	$55.90^{a}\pm0.21$
D	$5.64^{c}\pm0.05$	$3.57^{c}\pm0.10$	$2.82^{c}\pm0.05$	$21.50^{c}\pm0.04$	$15.52^{c}\pm0.04$	$45.94^{b}\pm6.97$
E	$5.89^{b}\pm0.01$	$4.90^{b}\pm0.08$	$3.39^{b}\pm0.09$	$22.40^{b}\pm0.04$	$19.76^{b}\pm0.13$	$43.64^{b}\pm0.07$
F	$6.68^{a}\pm0.03$	$5.72^{a}\pm0.05$	$3.96^{a}\pm0.03$	$22.83^{a}\pm0.06$	$22.08^{a}\pm0.04$	$38.75^{b}\pm0.05$

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% trifoliate yam flour + 0% Moringa seed flour
B = 85 % wheat flour + 10% trifoliate yam flour + 5 % Moringa seed flour
C = 75 % wheat flour + 20% trifoliate yam flour + 5 % Moringa seed flour
D = 65 % wheat flour + 30 % trifoliate yam flour + 5 % Moringa seed flour
E = 55 % wheat flour + 40 % trifoliate yam flour + 5 % Moringa seed flour
F = 45 % wheat flour + 50 % trifoliate yam flour + 5 % Moringa seed flour

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 (Opara, 2013; Igbabul*et al*, 2018). 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 (Ahmad *et al*., 2016).

Table 4: Physical Properties of Cookies from wheat, trifoliate yam and moringa seed flour blends

Samples	Diameter (cm)	Thickness (cm)	Weight (g)	Spread ratio
A	$4.50^{a}\pm0.28$	$1.30^{a}\pm0.00$	$10.80^{b}\pm0.14$	$4.00^{b}\pm0.24$
B	$4.65^{a}\pm0.21$	$1.20^{ab}\pm0.00$	$14.20^{ab}\pm2.41$	$3.74^{b}\pm0.16$
C	$4.75^{a}\pm0.07$	$1.20^{ab}\pm0.00$	$14.65^{ab}\pm2.19$	$4.13^{b}\pm0.06$
D	$4.80^{a}\pm0.42$	$1.10^{ab}\pm0.00$	$13.95^{ab}\pm2.19$	$3.92^{b}\pm0.36$
E	$4.85^{a}\pm0.28$	$1.05^{b}\pm0.07$	$13.55^{ab}\pm2.47$	$4.18^{b}\pm0.01$
F	$4.90^{a}\pm0.14$	$0.75^{c}\pm0.21$	$16.40^{a}\pm0.42$	$6.78^{a}\pm1.73$

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% trifoliate yam flour + 0% Moringa seed flour
B = 85 % wheat flour + 10% trifoliate yam flour + 5 % Moringa seed flour
C = 75 % wheat flour + 20% trifoliate yam flour + 5 % Moringa seed flour
D = 65 % wheat flour + 30 % trifoliate yam flour + 5 % Moringa seed flour
E = 55 % wheat flour + 40 % trifoliate yam flour + 5 % Moringa seed flour
F = 45 % wheat flour + 50 % trifoliate yam flour + 5 % Moringa seed flour

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 blendsare 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 B_3 and B_6 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 B_3 and B_6 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) (Chidinma *et al*., 2010). 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 (Kadiri, 2015). Niacin (vitamins B_3) and pyrodixine (vitamin B_6) decreased in composite cookies due to low values of B_3 and B_6 in both wheat, trifoliate yam and moringa seed. Chukwuka *et al*. (2013) reported low values of niacin (vitamin B_3) 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 (Chinma and Gernah, 2007). 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 (Wardlaw and Kessel, 2002). 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 (Chidinma *et al*., 2010).

Table 5: Vitamin content of cookies from wheat, trifoliate yam and moringa seed flour blends

Sample	Ascorbic Acid (Vitamin C)	β-Carotene (Pro-Vitamin A) (µg/100g)	Niacin (Vitamin B_3)	Pyrodixine (Vitamin B_6)
A	$0.57^{a}\pm0.02$	$0.26^{a}\pm0.04$	$0.69^{a}\pm0.00$	$0.11^{f}\pm0.00$
B	$9.39^{b}\pm0.06$	$5.47^{b}\pm0.16$	$0.45^{b}\pm0.00$	$0.10^{e}\pm0.00$
C	$9.73^{c}\pm0.04$	$5.91^{c}\pm0.00$	$0.44^{c}\pm0.01$	$0.08^{d}\pm0.00$
D	$10.31^{d}\pm0.02$	$6.34^{d}\pm0.25$	$0.43^{d}\pm0.00$	$0.07^{c}\pm0.00$
E	$11.91^{e}\pm0.04$	$6.49^{d}\pm0.03$	$0.39^{e}\pm0.01$	$0.07^{b}\pm0.00$
F	$12.95^{f}\pm0.01$	$7.37^{e}\pm0.04$	$0.38^{f}\pm0.00$	$0.06^{a}\pm0.00$

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% trifoliate yam flour + 0% Moringa seed flour
B = 85 % wheat flour + 10% trifoliate yam flour + 5 % Moringa seed flour
C = 75 % wheat flour + 20% trifoliate yam flour + 5 % Moringa seed flour
D = 65 % wheat flour + 30 % trifoliate yam flour + 5 % Moringa seed flour
E = 55 % wheat flour + 40 % trifoliate yam flour + 5 % Moringa seed flour
F = 45 % wheat flour + 50 % trifoliate yam flour + 5 % Moringa seed flour

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

Presented in Table 6 are data on the mineral content of cookies from wheat, trifoliate 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 trifoliate 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 to proteins, carbohydrates, fats and vitamins, they are inorganic or "ash constituents" of foods which cannot be destroyed by heating (Chidinma *et al*., 2010). Although they yield no energy, they have important roles to play in many activities in the body (Ihekoronye and Ngoddy, 1985). As ash content gives an insight to the mineral content of the food, hence, cookies produced from wheat, trifoliate 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 trifoliate 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 trifoliate 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 (Chidinma *et al*., 2010). 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 (Inyang and Ekop, 2015). 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 (Chidinma *et al*., 2010). Adesuyi and Ipinmoroti (2011), Samia *et al*. (2012), Chukwuka *et al*. (2013) and Kadiri (2015) revealed significant presence of mineral elements such as calcium, potassium, sodium and phosphorus in trifoliate yam.

Table 6: Mineral content of cookies from wheat, trifoliate yam and moringa seed flour blends

Samples	**Magnesium (Mg)**	**Calcium (Ca)**	**Potassium (K)**	**Iron (Fe)**
A	$143.00^{a}\pm0.85$	$252.60^{a}\pm0.28$	$26.55^{a}\pm0.21$	$21.55^{a}\pm0.21$
B	$157.50^{b}\pm0.42$	$269.40^{b}\pm0.35$	$28.10^{b}\pm0.00$	$33.48^{b}\pm0.33$
C	$161.60^{c}\pm0.21$	$273.50^{c}\pm0.50$	$28.55^{bc}\pm0.07$	$35.66^{c}\pm0.06$
D	$173.30^{d}\pm0.28$	$275.50^{d}\pm0.50$	$28.95^{c}\pm0.07$	$39.50^{d}\pm0.42$
E	$178.70^{e}\pm0.35$	$290.40^{e}\pm0.21$	$30.45^{d}\pm0.21$	$42.07^{e}\pm0.06$
F	$182.50^{f}\pm0.28$	$342.60^{f}\pm0.35$	$36.25^{e}\pm0.35$	$48.36^{f}\pm0.08$

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% trifoliate yam flour + 0% Moringa seed flour
B = 85 % wheat flour + 10% trifoliate yam flour + 5 % Moringa seed flour
C = 75 % wheat flour + 20% trifoliate yam flour + 5 % Moringa seed flour
D = 65 % wheat flour + 30 % trifoliate yam flour + 5 % Moringa seed flour
E = 55 % wheat flour + 40 % trifoliate yam flour + 5 % Moringa seed flour
F = 45 % wheat flour + 50 % trifoliate yam flour + 5 % Moringa seed flour

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

Data on the sensory attributes of cookies from wheat, trifoliate 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 trifoliate 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, trifoliate 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 (Dogo*et al*., 2018).
Appearance is an important sensory attribute of any food because of its influence on acceptability. The brown colour resulting from Maillard reaction is always associated with baked goods. The study showed significant decrease in the appearance of the cookies samples with increased trifoliate yam flour substitution. This is due to the darkish nature of trifoliate yam. According to Sudha *et al*. (2007), 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 (Manley *et al.*, 2002). Ubbor and Akobundu (2009) and Sengev*et al*. (2013) 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 trifoliate yam flour addition. This might be due to the bitter nature of the trifoliate 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*. (2009) and Mepba*et al.,* (2007) 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 trifoliate 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*. (2015). Mepba *et al.* (2007) and Joseph *et al*. (2016) reported similar decreased values of overall acceptability of wheat-based cookies supplemented with plantain and ripe banana slices flours respectively.

Table 7: Sensory Properties of Cookies from Wheat, Trifoliate Yam and Moringa Seed Flour Blends

Samples	Appearance	Flavor	Taste	Mouth Feel	Overall Acceptability
A	$8.40^{a}\pm0.68$	$8.55^{a}\pm0.51$	$8.40^{a}\pm0.60$	$8.10^{a}\pm0.72$	$8.25^{a}\pm0.72$
B	$7.85^{b}\pm0.81$	$7.70^{b}\pm0.80$	$8.00^{a}\pm0.65$	$7.10^{b}\pm0.72$	$7.60^{b}\pm0.94$
C	$7.45^{b}\pm0.60$	$6.80^{c}\pm1.11$	$7.90^{a}\pm0.72$	$6.85^{bc}\pm0.93$	$7.25^{b}\pm0.97$
D	$6.75^{c}\pm0.79$	$5.95^{d}\pm1.05$	$6.85^{b}\pm0.93$	$6.40^{cd}\pm1.39$	$6.05^{c}\pm1.10$
E	$5.15^{d}\pm0.75$	$5.55^{d}\pm1.28$	$6.30^{b}\pm1.22$	$6.35^{cd}\pm1.31$	$5.90^{c}\pm1.07$
F	$4.60^{e}\pm0.82$	$5.35^{d}\pm1.23$	$4.35^{c}\pm1.14$	$5.75^{d}\pm1.25$	$5.10^{d}\pm0.97$

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% trifoliate yam flour + 0% Moringa seed flour
B = 85 % wheat flour + 10% trifoliate yam flour + 5 % Moringa seed flour
C = 75 % wheat flour + 20% trifoliate yam flour + 5 % Moringa seed flour
D = 65 % wheat flour + 30 % trifoliate yam flour + 5 % Moringa seed flour
E = 55 % wheat flour + 40 % trifoliate yam flour + 5 % Moringa seed flour
F = 45 % wheat flour + 50 % trifoliate yam flour + 5 % Moringa seed flour

4. CONCLUSION AND RECOMMENDATIONS

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

The addition of trifoliate 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 trifoliate 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 $B_{3)}$ and pyrodixine (B_6) decreased as the level of trifoliate yam flour addition increased.

Sensory attributes of this study showed that the trifoliate 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 % trifoliate yam and 5% moringa seed flour was also highly acceptable.

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