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Nutritional Profile And Consumer Acceptability Of Biscuits Fortified With Sesame And Yellow Corn Blended Flour

Benedicta Galyuoni[1*] and Cornelia Tuolienuo[2]

[1]Department of Vocational and Technical Education, Al-Faruq College of Education
Box 146, Wenchi, Bono Region, Ghana
benedictagalyuoni90@gmail.com

[2]Department of Technical and Vocational Education and Training, NusratJahanAhmadiyya College of Education, Box 71- Wa, Upper West Region, Ghana
cornelianuo@gmail.com

Abstract

This study investigated the effect of sesame and maize flour replacement on the characteristics of biscuits. Five flour samples were formulated and coded as MN1 (100% wheat flour), MN2 (90% wheat flour, 4% sesame seeds flour, and 6% yellow corn flour), MN3 (80% wheat flour, 8% sesame seeds flour and 12% yellow corn flour), MN4 (70% wheat flour, 12% sesame seeds flour and 18% yellow corn flour) and MN5 (60% wheat flour, 15% sesame seeds flour and 25% yellow corn flour). The 100% wheat flour biscuit (WFB) was used as a control. A two-stage creaming method was used to prepare the biscuits. The study employed a 9-point hedonic scale to evaluate the biscuit samples using 50 semi-trained panelists. Data were analysed with the Analysis of Variance (ANOVA). The proximate composition (moisture, protein, ash, fat, fiber, and carbohydrate) of the wheat-sesame-yellow corn biscuits was analysed using standard analytical procedures (AOAC 2000). The moisture and ash content of the biscuit samples varied from 10.89-14.19% and 2.06-2.39% respectively. The fat and fiber content of the biscuit samples were 11.1-14.03 % and 0.36-1.29%. Protein and carbohydrate content were 3.95-9.59% and 67.44-67.38%. It was observed that increasing the proportions of sesame and maize flour in the biscuits resulted in a corresponding increase in ash, protein, fat, and fiber content in the biscuits. The sensory evaluation revealed no significant differences ($p<0.05$) between the 100% wheat flour biscuits and the biscuits sample made from 80% wheat flour, 8% sesame flour, and 12% yellow corn flour. This study suggests that sesame and maize flours can be used to make biscuits and that introducing composite flours up to 8% and 12% into wheat flour will help improve the quality of the biscuits.

Keywords: wheat flour, composite flour, biscuits, proximate analysis, sensory evaluation

Introduction

Biscuits are a popular snack that is enjoyed worldwide because they are inexpensive and easy to come by (Kulkarni, 1997). They are made from unsweetened pastry that is baked into tasty snacks (Onabanjo and Ighere, 2014). However, the bulk of these foods are protein-deficient, contributing to poor nutritional quality (Akpapunam and Darbe, 1999; Alobo, 2010). Because of their broad consumption and long shelf life it is suggested as a better use of composite flour than bread (McWatters et al., 2003).

Maize is high in vitamins, minerals, and fiber (Ullah et al., 2010). Whole corn, corn flour, cornstarch, corn gluten, corn syrup, tortillas, tortilla chips, polenta cornmeal, corn oil, popcorn, cornflakes, and so on are all examples. According to Enyisi et al., (2014) and Ullah et al., (2010), Maize seeds include moisture (11.6-20.0%), ash (1.10-2.95%), protein (4.50-9.87%), fat (2.17-4.43%), fiber (2.10-26.70%) and carbohydrate (44.60-69.60%) Maize also contains fiber and numerous B vitamins, although it lacks some elements including vitamin B12 and vitamin C (Cowieson, 2005; Höcherl et al., 2012).

Sesame seed is a staple food among many West Africa countries and it is grown in most of the country's middle belt and northern region of Ghana (Olanyanju et al., 2006). Sesame is a good source of oil (44-52.5%), protein (18-23.5%), and carbohydrates (13%) (Kahyaoglu, 2006 and Bamigboye et al., 2010). The seeds can be eaten raw, dry, or mixed with sugar. Because yellow maize and sesame are widely produced around the world, replacing yellow maize and sesame flour for wheat flour in biscuit making can help to reduce product costs while increasing nutritional content. Sesame will boost the protein, fat, and mineral content of the biscuit while also lowering incidences of numerous micronutrient deficiencies and protein-energy malnutrition (PEM) among individuals who consume it. In areas where wheat is not cultivated and must be imported for baking, the cost of producing biscuits is expensive.

Due to the high nutrient content of sesame and the high beta carotene content of yellow maize, using sesame and yellow maize composite flour in biscuits would assist to battle micronutrient deficit. Because biscuits are a popular item of consumption among all classes of people, they have a high potential for being employed as a food-based nutrition intervention to reach a wide range of impacted persons.

Partial replacement of wheat with yellow maize in biscuits preparation is intended to reduce celiac disease among gluten-intolerant people, increase food security, and improve customers' nutritional status. Researchers have identified the use of composite flour as a potential avenue for producing high-quality nutritious food products, reducing celiac disease, and reducing the massive amount of foreign exchange spent by Ghana, Nigeria and other West Africa countries on wheat flour importation (Nwosu, 2013; Vaugha et al., 2014). The influence of sesame and maize flour replacement on biscuit qualities was explored in this study.

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Materials and Methods

Source of Raw Materials

Two kilogram (2kg) of yellow maize (*Zea mays*) seed, 2 kg of sesame seed and 500g of processed wheat flour were purchased from Bolgatanga Central Market, Ghana. Other ingredients were also procured from a supermarket at Sumbrungu, Ghana.

Production of Maize Flour

In order to turn maize into flour, Mbata et al. (2009) used their approach. Maize flour was maintained in a refrigerator in a plastic container with a lid, from which samples were taken for biscuit making. Maize was properly cleaned by removing all broken kernels as well as other foreign particles, and then sifted to find the healthy ones. The maize kernels were then rinsed, steeped in 10 L of water, and allowed to sit at room temperature (27°C) for 72 hours. The maize was spread out on the trays and dried in a tray dryer (Model EU 850D, UK) at 50°C for 24 hours, with periodic stirring at 30-minute intervals to ensure uniform drying (Model Globe P44, China). A sieve with a mesh size of 0.45mm was used to pass the flour samples. It was then sealed in an airtight polyethylene bag and kept frozen until needed for examination.

Sesame flour

In order to make sesame flour, the method described by Ayinde et al., 2012 was used. Before being dried for six hours at 105^{o}C, sesame seeds were destoned and rinsed two times with potable water. The dried grains were blended with Kenwood food processor and sieved through a 250um mesh screen before being packaged in an airtight container for production and analysis.

Formulation of Composite flour Blends

To generate homogenous composite blends, wheat, sesame, and maize flours were completely blended together in a Kenwood mixer at different proportions of 100:0:0, 90:4:6, 80:8:12, 70:12:18, and 60:15:25. The composite blends were labeled and stored in plastic containers in the refrigerator for later use.

Table 1: Formulation of ingredients for biscuits preparation

INGREDIENTS	MN_1	MN_2	MN_3	MN_4	MN_5
Soft wheat flour (g)	100	90	80	70	60
Sesame flour (g)	0	4	8	12	15
Maize flour (g)	0	6	12	18	25
sugar (g)	25	25	25	25	25
Margarine (g)	40	40	40	40	40
Baking powder (g)	0.5	0.5	0.5	0.5	0.5
Milk powder (g)	1	1	1	1	1
Salt (g)	1	1	1	1	1

Nut meg	0.3	0.3	0.3	0.3	0.3
Vanilla essence (ml)	2	2	2	2	2

Keys: MN1(100% wheat flour), MN2(90% wheat flour, 4% sesame seeds flour and 6% yellow corn flour), MN3(80% wheat flour, 8% sesame seeds flour and 12% yellow corn flour), MN4(70% wheat flour, 12% sesame seeds flour and 18% yellow corn flour) and MN5(60% wheat flour, 15% sesame seeds flour and 25% yellow corn flour)

Production of Biscuits from Germinated Sesame and Wheat Flour

Aliyu and Sani (2009) method of biscuits making was used with minor modifications. Flour (wheat, sesame and maize flour) (100 g), sugar (10 g), margarine (30 g), salt (2 g), sodium bicarbonate (1 g), water (50 mls), milk (10 g), vanilla flavour (2mls). The two-stage creaming procedure was employed once they were properly weighed. In a Kenwood mixer (a 3-speed hand mixer), all of the ingredients were fully combined before being transferred to a bowl. The flours and sodium bicarbonate were mixed continuously for 15 minutes, until the dough was smooth. A piece of the dough was cut, placed on a clean platform, and rolled out with a rolling pin until it reached the necessary uniform texture and thickness. The pastry was cut into the desired shapes and sizes using a cookie cutter. These were placed on a baking sheet that had been prepared with margarine. Baked for 15–20 minutes at 200°C. The hot biscuits were removed from the pan and set to cool on a clean tray. After cooling, the biscuits were packed in polyethylene bagsfor further analysis.

Proximate Composition

Standard analytical procedures (AOAC 2000) were used to analyze the proximate composition (moisture, protein, fat, fiber, and carbohydrate) of the wheat-sesame-yellow cornbiscuits.

Oven Drying Method Moisture Content and Total Solids

Five grams (g) of the biscuit samples were transferred to the previously dried and weighed dish. The dish was placed in an oven and thermostatically controlled at 105 degrees for 5 hours. The dish was removed and placed in a desiccator to cool to room temperature and was weighed. It was then dried again for 30 minutes, cooled down again, and weighed. Drying, cooling, and weighing were repeated until a constant weight was reached. (Alternatively, samples could be dried in a thermostatically controlled oven for at least 8 hours, where a constant weight would be achieved. The determinations were duplicated and the average was found.

Calculations

$$\% \text{ Moisture (wt/wt)} = \frac{\text{wt } H_2O \text{ in sample}}{\text{Wt of wet sample}} \times 100$$

$$\% \text{ Moisture (wt/wt)} = \frac{\text{wt of wet sample - wt of dry sample}}{\text{Wt of wet sample}} \times 100$$

$$\% \text{ Total solids (wt/wt)} = \frac{\text{wt of dried sample}}{\text{Wt of wet sample}} \times 100$$

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Where wt = Weight of sample/spread

Ash content

Five grams 5g of the biscuits sample was weighed into a tarred crucible and was pre-dried. Crucibles were placed in a cool muffle furnace using tongs, gloves, and protective eyewear. The crucibles Ignited for 2 hours at about 600 degrees Celsius. The muffle furnace was turned off and opened when the temperature dropped to at least 250ºC preferably lower. The door was carefully opened to avoid losing ash that may be fluffy. Safety tongs were used to transfer crucibles to a desiccator with a porcelain plate and desiccant. The desiccator was closed and crucibles were allowed to cool before weighing.

Calculations

%Ash = wt of ash ×100

Wt of sample

%Ash = (wt of crucible + ash) – wt of empty crucible ×100

(wt of crucible + sample) – wt of empty crucible

Where wt = Weight of sample/spread

Fat content: soxhlet extraction

Previously dried (air oven at 100°C) 250 ml round bottom flask was weighed accurately. 5.0g of dried sample to 22 ×80mm paper thimble or a folded filter paper was weighed. A small piece of cotton or glass wool was placed into the thimble to prevent loss of the sample; 150ml of petroleum spirit B.P 40-60°C was added to the round bottom flask and assembled the apparatus. A condenser was connected to the soxhlet extractor and refluxed for 4 -6 hours on the heating mantle. After extraction, the thimble was removed and recovered solvent by distillation. The flask and fat/oil were heated in an oven at about 103°C to evaporate the solvent. The flask and contents were cooled to room temperature in a desiccator. The flask was weighed to determine the weight of fat/oil collected.

% Fat (dry basis) = fat/oil collected × 100

Weight of sample

% Fat (dry basis) = (wt of flask + oil) – wt. of flask × 100

Weight of sample

Crude fibre determination

Two grams (2g) of the sample from crude fat determination was weighed into a 750ml Erlenmeyer flask. Two hundred milliliters (200ml) of 1.25% H_2SO_4 was addedand immediately flask was set on hot plate and connected to the condenser. The contents were boiled within 1 minute of contact with solution. At the end of 30 minutes, flask was removed and immediately filtered through linen cloth in funnel and washed with a large volume of water. Filtrate (containing sample from acid hydrolysis) was washed and returned into the flask with 200ml 1.25% NaOH solutions. Flask was connected to the condenser and was boiled for exactly 30 minutes. It was then filtered through Fischer's crucible and washed thoroughly with water and added 15ml 96% alcohol. Crucible and contents was dried for 2 hour at 105 °C and cooled in

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desiccator and it was weighed. Crucible was ignited in a furnace for 30 minutes and after that it was cooled and reweighed.

$$\% \text{ Crude fibre} = \frac{\text{weight of crude fibre} \times 100}{\text{Weight of sample}}$$

$$\% \text{ Crude fibre} = \frac{\text{wt of crucible + sample (before – after) ashing} \times 100}{\text{Weight of sample}}$$

Where wt= Weight of sample/spread

Protein Determination

Digestion Method

The Kjeldahl technique was used to determine the crude protein content of the samples. The process consists of three fundamental steps: (1) digestion of the sample in sulfuric acid with a catalyst, which results in nitrogen conversion to ammonia; (2) distillation of the ammonia into a trapping solution; and (3) titration of the ammonia with a standard solution to determine its concentration. Percentage of the crude protein content of the samples equals percentage nitrogen 6.25, according to this approach.

Carbohydrate content

The calculation of available carbohydrate (nitrogen-free extract-NFE) was made after completing the analysis for ash, crude fiber, ether extract, and crude protein. The calculation was made by adding the percentage values on the dry matter basis of these analyzed contents and subtracting them from 100%.

Carbohydrate (%) =100 - (% moisture + % fat + % protein + % ash)

x. Calculation for dry basis = $\frac{(100 - \% \text{ moisture}) \times \text{wet basis}}{100}$

Sensory Analysis

Larmond's (1977) method was used to evaluate the five biscuit samples. A total of 50 semi-trained panelists participated in the evaluation. Colour, taste, flavour, texture, and general acceptability were used to evaluate the biscuits. The coded biscuit samples were given at room temperature on clean plastic plates in separate cubicles with adequate illumination. The panelists were given a random sample presentation. The goods were given to the panelists to test out and rate on a nine-point scale (9-like very much and 1-dislike very much).

Statistical Analysis

Data was subjected to a one-way analysis of variance (ANOVA). The Statistical Package for the Social Sciences (SPSS) version 20 was used to separate the means using Duncan's Multiple Range Test (IBM SPSS Statistics). A $P<0.05$ was used as the significance level.

Results and Discussion

Table 2 shows the results of the proximate composition of wheat-sesame-yellow maize flour biscuits. The moisture level of the flour samples ranged from 10.89 to 14.19%, with sample

MN1 (100% wheat flour) having the highest mean value (14.19%) and sample MN5 (60% wheat flour, 15% sesame seeds flour and 25% yellow corn flour) having the least (10.89%). The moisture level of the biscuits decreased as the level of sesame and yellow maize flour increased. The moisture level of many foods is an indicator of their water activity. These figures exceeded the moisture level of high-quality cassava flour samples, which ranged from 4.15 to 11.90% (Iwe et al, 2017). There was a significant difference ($P<0.05$) between the moisture content of biscuit made entirely of wheat flour and the composite biscuit samples (MN2, MN3, MN4 and MN5). According to Eriksson et al., 2014, low moisture content is required for product storage to prevent the growth of microbes, fermentation, and caking. The decrease in moisture content in composite biscuits could be due to higher protein levels from sesame flour inclusion (Alobo, 2006). This result also indicates that the biscuits samples will stay well if stored correctly in good circumstances Kent (1984). The moisture content of flour impacts its storage stability, hence the lower the moisture content of the flour, the higher the storage stability.

The ash content of the biscuit samples ranged from 2.06 to 2.37%, with sample MN5 (60% wheat flour, 15% sesame seeds flour and 25% yellow corn flour) having the highest (2.37%) and sample MN1 (100% wheat flour biscuit) having the lowest ash content (2.06%). With higher levels of sesame flour substitution in the blends, the ash content of the samples increased. The mineral substance in a food sample is reflected in the ash content. The fibre content ranged from 0.36 to 1.29%. Sample MN5 had the highest fibre content (1.29%) and the least was sample MN1 (100% wheat flour biscuit with 0.36% fibre content. With more sesame and maize flour substitutions, the fiber content increased. Food fibre aids in fat burning and immune system suppression. It may also offer dietary bulk, decrease constipation, and lower the risk of metabolic disorders (Farinde, 1984).

Sesame and yellow maize contain more crude fiber than wheat flour (Chinma et al., 2012; Christine et al., 2012). This was reflected in the amount of crude fiber found in biscuits made from wheat, beniseed, and maize composite flour. The crude fibre values obtained from all biscuit samples are within the acceptable range of 6 g/100g (FAO, 1994). The results showed a significant difference in ash and crude fiber content between biscuits made from 100% wheat flour and composite biscuits. Although biscuits made from composite flour have high ash and crude fiber content, this may be due to the influence of sesame and maize flour on the mineral content of the composite blend (Chinma et al., 2012). This suggested that the addition of this underutilized crops may increase the quantity of mineral intake in the food product (Oyetoro et al., 2007), and hence provide significant dietary amounts of mineral.

The value of protein in biscuit ranged from 3.95-9.59% with 100% wheat flour biscuit having the lowest protein content while sample MN5(60% wheat flour, 15% sesame seeds flour and 25% yellow corn flour) having the highest protein value (9.59%) . The high protein content of sesame flour is an indication that sesame is a better source of protein compared to wheat flour. It is also evident from the result, that increasing level of maize and sesame flour increased protein content of composite biscuits. The fat content of the biscuits ranged from 9.10-14.03% with the control sample MN1 (100) wheat flour biscuit) having the lowest fat content (9.110) while the highest fat content was found in biscuit sample MN5(60% wheat flour, 15% sesame seeds flour and 25%

yellow corn flour) with 14.03%. The increase in fat content in this study could be explained by the fact that sesame and maize flour have high fat content than wheat flour. The carbohydrate in the biscuit samples ranged from 67.14-67.44%. The carbohydrate values revealed that 100% wheat biscuits have the highest carbohydrate value. Because sesame flour has more protein, ash, and crude fiber than wheat flour, the increase in protein, ash, and crude fiber content of biscuits could be due to sesame and maize flour addition (El-Adawy, 1997). There were significant differences ($p \leq 0.05$) in protein, fats, moisture and carbohydrate content between biscuit produced from 100 % wheat flour and biscuits produced from wheat, sesame and maize composite flour.

Table 2: Proximate composition of wheat-yellow corn-sesame flour biscuits

Sample	**Moisture**(g/100g)	**Ash**(g/100g)	**Protein**(g/100g)	**Fat**(g/100 g)	**Fibre**(g/100 g)	**CHO**(g/100 g)
MN1	14.19^{a}	2.06^{e}	3.95^{e}	11.10^{e}	0.36^{e}	67.44^{a}
MN2	13.35^{b}	2.15^{d}	5.45^{d}	11.86^{d}	0.59^{d}	67.35^{b}
MN3	11.93^{c}	2.24^{c}	6.55^{c}	11.94^{c}	0.83^{c}	67.26^{c}
MN4	11.66^{d}	2.33^{b}	8.46^{b}	12.76^{b}	1.07^{b}	67.14^{e}
MN5	10.89^{e}	2.37^{a}	9.59^{a}	14.03^{a}	1.29^{a}	67.38^{d}

Values represent means and standard deviation replicate readings for various parameters. Values in the same column with different superscripts are significantly different ($p>0.05$). Keys: MN1(100% wheat flour), MN2(90% wheat flour, 4% sesame seeds flour and 6% yellow corn flour), MN3(80% wheat flour, 8% sesame seeds flour and 12% yellow corn flour), MN4(70% wheat flour, 12% sesame seeds flour and 18% yellow corn flour) and MN5(60% wheat flour, 15% sesame seeds flour and 25% yellow corn flour)

Sensory of wheat-yellow corn-sesame seeds biscuits

Sensory evaluation comprises factors such as appearance, aroma, taste, and so on, which serve to disclose the overall liking of finished products (Nafisah et al., 2020). Table 3 displays the sensory properties of wheat, sesame, and maize flour composite biscuits. The mean values of the panelists' evaluation results were statistically assessed to identify the significant difference between the five biscuit samples produced. The mean value of colour ranges from 8.00-8.64 with sample MN3 having the highest mean rating followed by MN2 and MN1 respectively. The control sample biscuit differed significantly ($p<0.05$) with the composite biscuit samples except for MN2.

The results of aroma ranged from 8.80-8.50 with composite biscuit sample MN5 having the highest mean score for aroma (8.80) whiles the lowest score was for control sample biscuit (8.50). The high mean score aroma ratings for the composite biscuit samples could be attributed to a corresponding increase in both sesame and maize flours. The texture of the biscuits samples ranged from 6.40-8.54 with biscuit samples MN1 and MN2 recording the highest mean ratings of 8.54 and 8.51 respectively with no significant difference ($p>0.05$) between the control biscuit sample MN1 and MN2. However, there were significant differences between the MN1 and MN3,

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MN4 and MN5. The tasteresult showed no significant differences (p>0.05) between the whole wheat (MN1) and fortified biscuit sample (MN2) but composite biscuit sample MN3 differed significantly with MN1 (control) and among the other biscuit composites.Overall Acceptability was among the parameters assessed.

Biscuit sample MN3 made with 80% wheat flour, 8% sesame seeds flour and 12% yellow corn flour was accepted by the evaluators. This means that sesame and maize flour could be used in the production of biscuits or pastry-based products to increase the nutritonal contents and also reduce the burden on wheat imports, making wheat based products affordable for consumers.

Table 3: Sensory of wheat-yellow corn-sesame seeds biscuits

Sample	Colour	Aroma	Texture	Taste	Overall Acceptability
MN1	8.30^{b}	8.50^{e}	8.54^{a}	8.29^{b}	8.53^{b}
MN2	8.34^{b}	8.56^{d}	8.51^{a}	8.32^{b}	8.55^{b}
MN3	8.64^{a}	8.64^{c}	8.46^{c}	8.38^{a}	8.64^{a}
MN4	8.14^{d}	8.72^{b}	7.41^{d}	7.53^{d}	7.61^{d}
MN5	8.00^{e}	8.80^{a}	6.40^{e}	7.40^{e}	7.54^{e}

Values represent means and standard deviation replicate readings for various parameters. Values in the same column with different superscripts are significantly different (p>0.05). Keys: MN1(100% wheat flour), MN2(90% wheat flour, 4% sesame seeds flour and 6% yellow corn flour), MN3(80% wheat flour, 8% sesame seeds flour and 12% yellow corn flour), MN4(70% wheat flour, 12% sesame seeds flour and 18% yellow corn flour) and MN5(60% wheat flour, 15% sesame seeds flour and 25% yellow corn flour)

Conclusion

The proximate composition and sensory qualities of wheat, sesame, and maize flour biscuits were investigated in this study. The proximate components (ash, protein, fat, and fiber of the control biscuit (MN1=100:0:0) looked considerably (P <0.05) lower. The variations in colour, aroma, texture, taste and overall acceptability of control sample was significantly different (P< 0.05) from composite biscuit samples MN3, MN4 and MN5 but the taste, texture and overall acceptability of MN2 was not different (P > 0.05) from the control biscuits sample. The composite biscuit with 8% sesame and 12% maize flour incorporation had a pleasant sensory appeal.

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