

EFFECT OF FERMENTATION ON THE CHEMICAL COMPOSITION OF WHEAT (*Triticum aestivum*) AND MAIZE (*Zea mays*) FLOURS AND SENSORY EVALUATION OF BISCUITS MADE FROM THEIR FLOURS

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ABSTRACT

Background: Fermentation improves the nutritional value, acceptability and safety of foods.

Objective: This study assessed the effect of fermentation on the chemical composition of wheat and maize flours and consumer acceptability of biscuits made from their flours.

Methods: Fermentation of wheat and maize: Wheat and maize grains were sorted respectively and were divided into five parts of 200g each. They were labelled as W₀, W₁, W₂, W₃ and W₄ for wheat and M₀, M₁, M₂, M₃ and M₄ for maize samples. Each sample was washed with tap water three times. W₀ and M₀ were not fermented while W₁, W₂, W₃ and W₄ and M₁, M₂, M₃ and M₄ were soaked in 500mls of water in a bowl and were fermented for 24 hours, 48 hours, 72 hours and 96 hours respectively. The flour of each sample was used for baking biscuits. Proximate, mineral and vitamin content of the flour samples and the sensory properties of the biscuits produced from their flour were evaluated using standard analytical methods. One way analysis of variance and Duncan's multiple range test were used to separate the means among the samples.

Result: The highest ash (2.14%), crude fibre (2.03%) and fat (4.24%) values were observed in sample M₀. Sample M₄, W₄ and W₀ had the highest moisture (9.67%), protein (11.62%) and carbohydrate (77.89%) values respectively. Sample M₀ had the highest magnesium (35.62mg), potassium (162.59mg) and sodium (13.79mg) values, M₁ had the highest iron (0.76mg) content while the highest calcium (18.77mg) zinc (0.75mg) and phosphorus (132.59mg) values were observed in sample W₀. The highest vitamin B₁ (0.59mg), vitamin B₃ (0.24mg), vitamin A (18.76µg) and folic acid (41.64mg) were observed in sample M₀ while the highest vitamin B₂ (0.04mg) value was found in both sample M₀ and sample M₁. Sample W₀ had the highest vitamin C (6.36mg) and vitamin B₆ (1.87mg) content. There was no significant (p>0.05) difference in the acceptability of the biscuit samples. However, the taste, aroma, texture and general acceptability of the biscuits produced from all the samples had appreciable ratings.

Conclusion: Fermentation improved the nutritional quality of cereals while biscuits produced from fermented cereals were generally acceptable.

Key words: Wheat, Maize, Fermentation, Biscuit.

INTRODUCTION

Cereal grains are the edible seeds of plants which belong to the monocotyledonous grass family *Poaceae* also referred to as *Gramineae* (1). The history of the use of cereals for food by human dates back to about 100 BC (2). Cereals are the staple foods of many people both in the developed and developing countries (3) and represent around 73% of the total world plant produce that is harvested annually (4). The major cereals consumed in Nigeria include maize, millet, sorghum, fonio, wheat and oat. Food products obtained from cereals include breakfast cereals, noodles, pasta, tortillas, beer, wine, bread and biscuits (5).

Cereal grains are significant sources of nutrients such as carbohydrates, proteins, vitamins and minerals as well as non-nutrients such as dietary fibre (6). They are also important sources of phytochemicals such as ascarotenoids, tocopherols, flavonoids and tocotrienols (7). In addition to their nutrient content, cereals are beneficial in the maintenance of health and prevention of diseases such as cardiovascular diseases

(8) and type 2 diabetes mellitus (9). These protective roles of cereals are however, linked to the colonic fermentation of their dietary fibre content.

Fermentation is among the oldest methods of processing food. It is a process by which chemical compounds are broken down by bacteria yeast or other microorganisms with the release of heat and production of effervescence. Fermentation improves the digestibility and breakdown of oligosaccharides and dietary fibre. It enhances the nutritional value, acceptability (11) and safety of foods (12). Fermentation also reduces the activity of antinutrients such as tannins, phytate and oxalate (10).

Major cereal products obtained by fermentation in Nigeria include bread, pap, alcoholic beverages such as beer, vodka and whiskey (13). Previous studies have explored the nutrients and probiotic microorganism associated with fermented foods (2; 4 and 6). However, there is paucity of data on the effect of fermentation on the nutrient composition and consumer acceptability of biscuit.

The general objective of this study was therefore, to

evaluate the effect of fermentation on the chemical composition of wheat and maize flour and sensory evaluation of biscuits made from their flour. Specifically, this study examined the proximate, mineral and vitamin composition of wheat and maize flour before and after fermentation and evaluation of the sensory properties of biscuits produced from wheat and maize flour before and after fermentation

Materials and Methods

The wheat and maize grains as well as the ingredients used in producing biscuit such as granulated sugar, margarine, baking powder, milk powder and egg were purchased from Eke UkwuOwerri market in Owerri Imo State, Nigeria.

Fermentation of wheat and maize

Wheat and maize grains were sorted respectively and were divided into five parts of 200g each. They were labelled as W_0, W_1, W_2, W_3 and W_4 for wheat and M_0, M_1, M_2, M_3 and M_4 for maize samples. Each sample was washed with tap water three times. W_0 and M_0 were not fermented while W_1, W_2, W_3 and W_4 and M_1, M_2, M_3 and M_4 were soaked in 500mls of water in a bowl and were fermented for 24 hours, 48 hours, 72 hours and 96 hours respectively. The water in each sample was changed after each 24 hours.

Preparation of wheat and maize flours

At the end of fermentation, the wheat and maize samples were oven dried at 80°C for 5 hour and milled into fine flour using still disc mill(model -2A milling machine) to pass through 250µm sieve. The flour samples were then stored in air tight containers for use.

Recipe for the preparation of Biscuits

The preparation of the biscuit was carried out using the rubbing in method according to Pickett(14) with slight modifications. The ingredients used for biscuit making were 250g flour (1 cup), 50g margarine, 2 table spoons of sugar, 1 medium sized egg, 1 teaspoon of baking powder, ½ teaspoon of salt and ¼cup of milk.

- Flour and margarine were thoroughly mixed together in a large bowl. Sugar and baking powder and salt were added into the mixture and were thoroughly mixed together. Thereafter, egg and milk were added and mixed together.
- The dough was kneaded on a surface that has been floured lightly to about 0.5cm tick, cut into rectangular shapes using cookie cutter and placed on a greased baking pan.
- The biscuit was baked in the oven at 150°C for approximately 15 minutes or till the biscuits turned golden brown. The biscuits were cooled on the tray and stored in tightly covered containers.

Chemical Analysis

The moisture, protein, fat ash and crude fibre contents of the flour samples were determined according to the official method of analysis described by the association of official and analytical chemist (15).The kjeldahl method was used to determine the protein

content (15), fat was determined by the Soxhlet extraction method (15), moisture was determined using hot air oven method (15). Ash was determined by weighing 1g of each sample into a tarred porcelain crucible. It was incinerated at 600°C for six hours in an ashing muffle furnace until ash was obtained (15). The carbohydrate content was determined by difference. The minerals phosphorous, calcium, magnesium, iron, and zinc were determined using Atomic Absorption Spectrophotometer described by Ranjiham and Gopa (16). Potassium and sodium were determined using flame photometer, the vitamins were determined using AOAC (17).

Sensory Evaluation

The sensory characteristics were carried out using one hundred panelists which comprises of both students and staff of the Nutrition and Dietetic Department, Imo State University Owerri, Nigeria. The parameters such as colour, flavour, taste, texture and overall general acceptability of the biscuit samples were analysed using a 9 point hedonic scale. Where 9 = extremely liked, 8 = liked very much, 7 = liked moderately, 6 = like much, 5 = neither like nor dislike, 4 = dislike, 3 = dislike moderately, 2 = dislike very much, 1 = disliked extremely. They samples were served simultaneously in clean white plates. Tap water was provided for rinsing of mouth between samples

Statistical Analysis

The data obtained was subjected to analysis of variance (ANOVA) and least significant difference and Duncan's test were used to separate the means among the sample using Statistical Products for Service Solutions (SPSS) version

21.0 RESULTS

The proximate composition of the fermented and unfermented wheat and maize flour is presented in table 1. There was significant ($p < 0.05$) drop in the fat and crude fibre content of the samples while moisture content was significantly increased after fermentation in both the wheat and maize samples. The highest ash (2.14%), crude fibre (2.03%) and fat (4.24%) values were observed in sample M_0 . Sample M_4 , W_4 and W_0 had the highest moisture (9.67%), protein (11.62%) and carbohydrate (77.89%) values respectively. Sample W_4 had the lowest ash (1.68%), crude fibre (1.77%) and fat (1.77%) values. Sample M_0 had the lowest protein (10.79%) and moisture (5.51%) content while sample M_4 had the lowest carbohydrate (71.19%) content.

Sample (%)	Moisture (%)	Ash (%)	Crude Fibre (%)	Fat (%)	Protein (%)	Carbohydrate (%)
W ₀	... ^b ±0.11	1.93 ^f ±0.01	1.89 ^g ±0.02	1.87 ^d ±0.01	10.87 ^a ±0.04	77.89 ^a ±0.01
W ₁	6.20 ^c ±0.02	1.83 ^d ±0.01	1.87 ^e ±0.01	1.86 ^e ±0.01	11.26 ^a ±0.04	77.09 ^a ±0.01
W ₂	6.22 ^d ±0.02	1.77 ^c ±0.01	1.84 ^d ±0.02	1.85 ^c ±0.01	11.39 ^a ±0.07	77.05 ^a ±0.01
W ₃	7.71 ^e ±0.15	1.75 ^b ±0.04	1.81 ^b ±0.01	1.81 ^b ±0.01	11.50 ^a ±0.14	75.74 ^a ±0.01
W ₄	7.87 ^f ±0.03	1.68 ^a ±0.01	1.77 ^a ±0.01	1.77 ^a ±0.07	11.62 ^a ±0.24	75.22 ^a ±0.06
M ₀	5.51 ^a ±0.12	2.14 ^j ±0.01	2.03 ^j ±0.01	4.24 ^j ±0.01	10.79 ^a ±0.01	75.79 ^a ±0.02
M ₁	7.71 ^c ±0.12	2.11 ⁱ ±0.05	1.93 ⁱ ±0.02	4.19 ⁱ ±0.01	10.87 ^a ±0.09	73.52 ^a ±0.02
M ₂	8.46 ^g ±0.37	2.07 ^h ±0.01	1.91 ^h ±0.01	3.90 ^h ±0.05	10.85 ^a ±0.09	72.66 ^a ±0.26
M ₃	8.56 ^h ±0.19	1.95 ^g ±0.01	1.88 ^f ±0.02	3.89 ^g ±0.01	11.32 ^a ±0.10	72.43 ^a ±0.02
M ₄	9.67 ⁱ ±0.04	1.88 ^c ±0.01	1.82 ^c ±0.11	3.52 ^f ±0.11	11.46 ^a ±0.04	71.19 ^a ±0.01

Table 1: Proximate composition of unfermented and fermented wheat and maize samples

Values are means ± standard deviation of the triplicate determinations. Means with same superscript within the same column are not significantly different ($p>0.05$) while different superscript within the same column are significantly different ($p \leq 0.05$).

Key:

W₀=0hrs of wheat fermentation M₀=0hrs of maize fermentation
W₁=24hrs of wheat fermentation M₁=24hrs of maize fermentation
W₂=48hrs of wheat fermentation M₂=48hrs of maize fermentation
W₃=72hrs of wheat fermentation M₃= 78hrs of maize fermentation
W₄=96hr of wheat fermentation M₄= 96hrs of maize fermentation

Table 2 shows the mineral content of the fermented and unfermented wheat and maize samples. There was no significant ($p>0.05$) difference among the samples. Sample M₀ had the highest magnesium (35.62mg), potassium (162.59mg) and sodium (13.79mg) values, M₁ had the highest iron (0.76mg) content while the highest calcium (18.77mg) zinc (0.75mg) and phosphorus (132.59mg) values were observed in sample W₀. The lowest calcium (11.29mg), zinc (0.48mg) and phosphorus (124.52mg) content were

observed in sample M₄. The lowest sodium (8.44mg) value was observed in both W₄ and W₃. Sample W₄ had the lowest magnesium (28.50mg) and potassium (148.15mg) values while W₃ had the lowest iron (0.49mg) content.

Table 2: Mineral content of unfermented and fermented wheat and maize samples

Sample	Calcium (mg/100g)	Magnesium (mg/100g)	Iron (mg/100g)	Potassium (mg/100g)	Sodium (mg/100g)	Zinc (mg/100g)	Phosphorus (mg/100g)
W ₀	18.77 ^a ±0.01	31.71 ^a ±0.12	0.59 ^a ±0.01	154.87 ^a ±0.04	9.57 ^a ±0.04	0.75 ^a ±0.01	132.59 ^a ±0.01
W ₁	17.43 ^a ±0.01	32.62 ^a ±0.24	0.52 ^a ±0.01	154.83 ^a ±0.09	9.81 ^a ±0.04	0.71 ^a ±0.01	130.59 ^a ±0.01
W ₂	16.26 ^a ±0.02	32.47 ^a ±0.38	0.51 ^a ±0.02	152.51 ^a ±0.26	9.51 ^a ±0.12	0.62 ^a ±0.01	128.67 ^a ±0.09
W ₃	16.23 ^a ±0.04	28.72 ^a ±1.24	0.49 ^g ±0.01	150.78 ^a ±0.02	8.84 ^a ±0.08	0.58 ^a ±0.01	126.77 ^a ±0.03
W ₄	15.85 ^a ±0.09	28.50 ^a ±0.36	0.53 ^a ±0.01	148.15 ^a ±1.10	8.44 ^a ±0.21	0.54 ^a ±0.02	125.82 ^a ±0.02
M ₀	12.34 ^a ±0.08	35.62 ^a ±0.24	0.72 ^a ±0.01	162.59 ^a ±0.15	13.79 ^a ±0.01	0.59 ^a ±0.01	127.64 ^a ±0.22
M ₁	12.28 ^a ±0.16	34.29 ^a ±0.01	0.76 ^a ±0.02	161.72 ^a ±0.16	13.32 ^a ±1.06	0.61 ^a ±0.01	127.57 ^a ±0.01
M ₂	11.86 ^a ±0.01	33.67 ^a ±0.04	0.68 ^a ±0.01	161.52 ^a ±0.10	12.87 ^a ±0.04	0.54 ^a ±0.01	125.31 ^a ±0.72
M ₃	12.13 ^a ±0.04	32.85 ^a ±0.09	0.63 ^a ±0.02	158.77 ^a ±0.34	12.87 ^a ±0.04	0.52 ^a ±0.02	126.79 ^a ±0.01
M ₄	11.29 ^a ±0.01	32.77 ^a ±0.04	0.57 ^a ±0.04	156.57 ^a ±0.38	12.48 ^a ±0.31	0.48 ^a ±0.01	124.52 ^a ±0.25

Values are means \pm standard deviation of triplicate determinations

Means with same superscript within the same column are not significantly different ($p > 0.05$) while different superscript within the same column are significantly different ($p < 0.05$).

Key:

W ₀ =0hrs of wheat fermentation	M ₀ =0hrs of maize fermentation
W ₁ =24hrs of wheat fermentation	M ₁ =24hrs of maize fermentation
W ₂ =48hrs of wheat fermentation	M ₂ =48hrs of maize fermentation
W ₃ =72hrs of wheat fermentation	M ₃ = 78hrs of maize fermentation
W ₄ =96hr of wheat fermentation	M ₄ = 96hrs of maize fermentation

Table 3 shows the vitamin content of the fermented and unfermented wheat and maize samples. There was no significant ($p > 0.05$) difference among the samples. The highest vitamin B₁ (0.59mg), vitamin B₃ (0.24mg), vitamin A (18.76 μ g) and folic acid (41.64mg) were observed in sample M₀ while the highest vitamin B₂ (0.04mg) value was found in both

sample M₀ and sample M₁. Sample W₀ had the highest vitamin C (6.36mg) and vitamin B₆ (1.87mg) content. Sample W₄ had the lowest vitamin B₁ (0.29mg), vitamin B₂ (0.01mg), vitamin A (4.57 μ g) and folic acid (28.01mg) while sample M₄ had the lowest vitamin B₃ (0.11mg), vitamin B₆ (0.68mg) and vitamin C (3.18mg).

Table 3: Vitamin content of unfermented and fermented wheat and maize samples

Sample	Vitamin B ₁ (mg/100g)	Vitamin B ₂ (mg/100g)	Vitamin B ₃ (mg/100g)	Vitamin C (mg/100g)	Vitamin A (μ g/g)	Vitamin B ₆ (mg/100g)	Folic (mg/100g)
W ₀	0.46 ^a \pm 0.01	0.02 ^a \pm 0.00	0.13 ^a \pm 0.02	6.36 ^a \pm 0.02	5.77 ^a \pm 0.01	1.87 ^a \pm 0.01	38.77 ^a \pm 0.04
W ₁	0.42 ^a \pm 0.01	0.02 ^a \pm 0.00	0.16 ^a \pm 0.01	6.22 ^a \pm 0.03	5.25 ^a \pm 0.03	1.75 ^a \pm 0.01	38.47 ^a \pm 0.31
W ₂	0.38 ^a \pm 0.02	0.02 ^a \pm 0.00	0.14 ^a \pm 0.01	5.47 ^a \pm 0.01	4.71 ^a \pm 0.01	1.67 ^a \pm 0.00	35.61 ^a \pm 0.26
W ₃	0.32 ^a \pm 0.01	0.02 ^a \pm 0.00	0.16 ^a \pm 0.01	4.77 ^a \pm 0.02	4.66 ^a \pm 0.05	1.41 ^a \pm 0.02	32.86 ^a \pm 0.02
W ₄	0.29 ^a \pm 0.01	0.01 ^a \pm 0.00	0.12 ^a \pm 0.01	4.77 ^a \pm 0.04	4.57 ^a \pm 0.02	1.36 ^a \pm 0.02	28.01 ^a \pm 0.55
M ₀	0.59 ^a \pm 0.01	0.04 ^a \pm 0.00	0.24 ^a \pm 0.01	5.87 ^a \pm 0.03	18.7a ^a \pm 0.02	0.85 ^a \pm 0.01	41.64 ^a \pm 0.01
M ₁	0.56 ^a \pm 0.04	0.04 ^a \pm 0.00	0.21 ^a \pm 0.04	5.43 ^a \pm 0.02	15.13 ^a \pm 0.01	0.82 ^a \pm 0.01	39.27 ^a \pm 0.74
M ₂	0.48 ^a \pm 0.01	0.03 ^a \pm 0.00	0.19 ^a \pm 0.01	4.86 ^a \pm 0.05	13.76 ^a \pm 0.01	0.78 ^a \pm 0.01	38.67 ^a \pm 0.09
M ₃	0.45 ^a \pm 0.02	0.03 ^a \pm 0.00	0.14 ^a \pm 0.01	3.34 ^a \pm 0.07	13.22 ^a \pm 0.02	0.74 ^a \pm 0.01	36.52 ^a \pm 0.33
M ₄	0.40 ^a \pm 0.02	0.02 ^a \pm 0.00	0.11 ^a \pm 0.01	3.18 ^a \pm 0.01	12.34 ^a \pm 0.02	0.68 ^a \pm 0.01	34.78 ^a \pm 0.02

Values are means \pm standard deviation of the triplicate determinations.

Means with same superscript within the same column are not significantly different ($p > 0.05$) while different superscript within the same column are significantly different ($p < 0.05$).

Key:

W ₀ =0hrs of wheat fermentation	M ₀ =0hrs of maize fermentation
W ₁ =24hrs of wheat fermentation	M ₁ =24hrs of maize fermentation
W ₂ =48hrs of wheat fermentation	M ₂ =48hrs of maize fermentation
W ₃ =72hrs of wheat fermentation	M ₃ = 78hrs of maize fermentation
W ₄ =96hr of wheat fermentation	M ₄ = 96hrs of maize fermentation

Table 4 shows the sensory properties of the biscuits. There was no significant ($p > 0.05$) difference in the sensory properties of the biscuit samples. The highest taste (7.84), aroma (8.03), texture (7.82), colour (7.97) and general acceptability (8.08) were observed in sample W₀. Sample M₂ had the lowest taste (6.15) and

colour (6.62) values. The lowest aroma (6.06) was observed in both sample W₂ and W₃. The lowest texture (6.35) value was observed in sample W₁ while the lowest general acceptability (7.14) value was observed in both sample W₂ and M₂.

Table 4: Sensory attributes of unfermented and fermented biscuits samples

Sample	Taste	Aroma	Texture	Colour	General acceptability
W ₀	7.84 ^a ±0.05	8.03 ^a ±0.01	7.82 ^a ±0.02	7.97 ^a ±0.01	8.08 ^a ±0.01
W ₁	6.64 ^e ±0.02	6.14 ^a ±0.01	6.35 ^a ±0.02	6.93 ^a ±0.04	7.39 ^a ±0.02
W ₂	7.24 ^a ±0.01	6.06 ^a ±0.03	6.88 ^a ±0.02	6.67 ^a ±0.04	7.14 ^a ±0.02
W ₃	7.00 ^a ±0.01	6.06 ^a ±0.03	6.80 ^a ±0.01	6.82 ^a ±0.01	7.63 ^a ±0.03
W ₄	6.65 ^a ±0.01	6.14 ^a ±0.02	6.83 ^a ±0.01	7.12 ^a ±0.01	7.28 ^a ±0.07
M ₀	7.64 ^a ±0.01	7.14 ^a ±0.01	6.92 ^a ±0.01	7.83 ^a ±0.02	7.94 ^a ±0.01
M ₁	6.64 ^a ±0.01	6.62 ^a ±0.02	6.64 ^a ±0.01	7.36 ^a ±0.02	7.53 ^a ±0.02
M ₂	6.15 ^a ±0.03	7.62 ^a ±0.01	6.93 ^a ±0.02	6.62 ^a ±0.03	7.14 ^a ±0.02
M ₃	6.62 ^a ±0.01	6.72 ^a ±0.02	7.13 ^a ±0.02	6.81 ^a ±0.01	7.19 ^a ±0.01
M ₄	7.27 ^a ±0.04	6.74 ^a ±0.03	7.65 ^a ±0.01	7.65 ^a ±0.02	7.84 ^a ±0.05

Values are means ± standard deviation of the 100 panelists.

Means with same superscript within the same column are not significantly different ($p>0.05$) while different superscript within the same column are significantly different ($p<0.05$).

Key:

W₀=0hrs of wheat fermentation M₀=0hrs of maize fermentation
W₁=24hrs of wheat fermentation M₁=24hrs of maize fermentation
W₂=48hrs of wheat fermentation M₂=48hrs of maize fermentation
W₃=72hrs of wheat fermentation M₃=78hrs of maize fermentation
W₄=96hr of wheat fermentation M₄=96hrs of maize fermentation

DISCUSSIONS

In this study, the effect of fermentation on the chemical composition of wheat and maize flours and sensory evaluation of biscuits made from their flour was investigated. There was significant ($p<0.05$) increase in the moisture content of the wheat and maize samples from 5.68% and 5.51% before fermentation to 7.87% and 9.67% after 96 hours of fermentation respectively. This increase in their moisture content could be associated with the absorption of water used for fermentation. The marked decrease in the ash content of the samples with fermentation is in agreement with report by Michodjehoun *et al* (18) and also similar observation by Apena (19) reported a reduction in the ash content of maize, sorghum and millet after 72 hours of fermentation. This may be due to the leaching of some of the minerals into the aqueous medium used for the fermentation, which was discarded.

This study observed a reduction in the carbohydrate and crude fibre contents of the cereals after fermentation. This decrease in carbohydrate and crude fibre content of maize and wheat grains after fermentation suggests that they are good substrates for the fermenting microorganisms. It also indicates that fermentation of cereals could be beneficial in managing the symptoms of irritable bowel syndrome (IBS) in individuals whose symptoms of IBS are worsened by consumption of fermentable oligosaccharides, disaccharides, monosaccharides and polyols (FODMAPS) foods (20). The marked reduction in the fat content of the selected cereal samples suggests that fermentation of cereals could be of interest to overweight and obese individuals in weight management. The increased protein content of the cereals after fermentation is similar to the findings of

(21) who reported increased protein content in fermented maize flour and (19) who reported increased protein in maize sorghum and millet grains after 72 hours of fermentation. This increase in protein content could be linked with the activities of proteolytic enzymes produced by microorganisms during fermentation (21).

There were insignificant drops in the values of all the micro nutrients investigated in this study after fermentation for 96 hours. This is related to the findings of (19). The lowest calcium (11.29mg), zinc (0.48mg) and phosphorus (124.52mg) content were observed in the maize sample after 96 hours of fermentation. The lowest sodium (8.44mg) value was observed in the wheat samples at both 72 hours and 96 hours of fermentation. The lowest magnesium (28.50mg) and potassium (148.15mg) values were observed in the wheat sample after 96 hours of fermentation while the lowest iron (0.49mg) content was observed in wheat sample after 72 hours of fermentation.

This considerable decrease in the values of minerals could be associated with the leaching of these mineral elements into the aqueous medium as the period of fermentation increases. The reduction of the sodium content of the cereals after 96 hours of fermentation suggests that consuming fermented foods could be beneficial in the prevention and management of high blood pressure as salt intake has been shown to be associated with the risk of having high blood pressure and stroke.

All the vitamins investigated in this study were significantly reduced after fermentation for 96 hours. This is related to the findings of (18). The lowest vitamin A (4.57µg) vitamin B₁ (0.29mg), vitamin B₂ (0.01mg), and folic acid (28.01m) were observed in the

wheat sample after 96 hours of fermentation while the lowest vitamin B₃ (0.11mg) vitamin C (3.18mg) and vitamin B₆ (0.68mg) were observed in the maize sample after 96 hours of fermentation. Like the minerals, the marked reduction in the vitamin content of the wheat and maize samples after 96 hours of fermentation could be related to the leaching of these mineral elements into the aqueous medium as the period of fermentation increases. More so, it could have been utilized by the fermenting microorganisms since an important function of vitamins and minerals is to aid in metabolism (22).

The result of the sensory evaluation indicated that all the samples had appreciable ratings for taste, aroma, texture, colour and general acceptability. However, the unfermented wheat sample had higher preference in all the attributes tested.

Conclusion

The nutritional composition of wheat and maize flours were considerably improved by fermentation in this study. Acceptable biscuits were produced from both the fermented and unfermented wheat and maize flour samples. Fat is an important ingredient used in baking biscuits. It is usually the third largest component after flour and sugar. The fermentation of cereals in a bid to reduce the fat content of flour used for baking biscuit is likely to be beneficial in the maintenance of healthy nutritional status. Therefore, fermentation of cereal grains should be encouraged as a means of improving the nutritional quality of baked products.

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