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Production and Quality Evaluation of Biscuits from Blends of Wheat, Millet and Sesame Seeds Composites: Functional and Nutrients Characteristics

Irine Mengeneh[1, *], Charles Chukwuma Ariahu[2]

[1]Center for Food Technology and Research, Benue State University, Makurdi, Nigeria

[2]Department of Food Science and Technology, University of Agriculture, Makurdi, Nigeria

Email address:

imengeneh@ gmail.com (I. Mengeneh), ariahucc@yahoo.com (C. C. Ariahu)

[*]Corresponding author

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Abstract: The study was designed to produce biscuits from blends of wheat, millet, sesame seeds composites with the outcome of boosting the nutritional value of the biscuits and increasing the utilisation of millet and sesame which are locally grown crops thereby reducing the over dependence of wheat importation. Millet and sesame were processed into flours and mixed with wheat flour at different proportion (100:0:0, 90:5:5, 85:10:5, 80:15:5 and 75:20:5) to produce biscuits. The flours produced were analysed for functional properties, anti-nutrient, proximate and minerals while biscuits produced were analysed for: anti-nutrients, proximate, and minerals. The functional properties of flours; bulk density, swelling capacity, OAC, WAC, and foaming capacity ranged from 0.88-0.993 g/cm^3, 1.224-1.65g/mL, 0.846-1.835 g/L, 1.44-2.25ml/g, 8.05-11.03%. The anti-nutritional properties: Cyanide, phytates, oxalate and tannin content of flours ranged from 0.037 to 0.086 mg/kg, 0.064 to 0.556mg/kg, 0.317 to 0.571mg/kg, and 3.51 to 5.03mg/kg respectively. The cyanide content for biscuit was negligible (<0.001) while the phytates, oxalate and tannin ranged from 0.052-0.085mg/kg, 0.113-0.166mg/kg and 1.41-2.22mg/kg respectively. For the Proximate and mineral composition of flour and biscuits samples, Moisture, Protein, fats, crude fibre, ash, carbohydrates and energy values ranged from 13.30 to 14.92 g/100g, 9.65 to 16.53g/100g, 0.19 to 1.56 g/100g, 3.62 to 4.62 g/100g, 1.09 to 1.59g/100g, 72.16 to 60.78g/100g and 1397.81 to 1372.01kJ/100g for flour samples respectively. whereas in biscuits, it ranged from 6.85 to 8.78g/100g, 9.00 to 16.18g/100g, 1.96 to 2.76g/100g, 2.20 to 2.97g/100g, 78.98 to 68.21g/100g and 1568.02 to 1536.92KJ/100 respectively. The mineral composition in flour samples ranged from 304.7 to 330.6 mg/100g for Ca, 281.7 to 299.0mg/100g for Mg, 5.3 to 6.9 mg/100g for Fe, 8.4 to 10.1 mg/100g for Zn, 2.63 to 3.9mg/100g for Mn and 0.02 to 0.18mg/100g for Cu. The As and Pb values were the same in both flour and biscuits samples (<0.001mg/100g). The mineral content for biscuits ranged from 205 to 246 mg/100g for Ca, 196.7 to 221.7 mg/100g for Mg, 4.7 to 6.3 mg/100g for Fe 7 to 9.13 mg/100g for Zn, 1.8 to 3.7mg/100g for Mn and 0.01 to 0.09mg/100g for Cu.

Keywords: Proximate Composition of Biscuits, Minerals, Anti-nutrients, Wheat Flour, Millet Flour, Sesame Seed Flour, Sensory

1. Introduction

Biscuits are tasty and nutritious snacks which are usually consumed with tea or coffee [1]. They have very good potentials of being used as vehicle for fortification programme because biscuits are commonly consumed by all classes of people [1]. Biscuit is easily digestive, very nutritious, and can keep on the shelve for long periods [2]. Biscuits have been suggested as a better use of composite flours compared to bread because of their higher nutrients density and longer shelf life [3]. Wheat flour constitutes the basic ingredients for biscuits production because of its gluten content, which is not present in other cereals [4]. Wheat flours are called soft or weak if gluten content is low and hard or strong if they have high gluten content [4]. Marketing forecasts suggest that global biscuit sales will grow significantly by 2020, and healthy biscuits are expected to perform well in this sector [5]. Fortification of food products plays an important role in increasing health promoting functional components in bakery products to provide additional benefits to meet consumers' demands [6]. There is also a good possibility of improving the overall nutritional contribution of biscuits by reducing the content of wheat flour [7].

Sesame (Sesamum indicum) commonly known as benniseed belongs to the Pedaliaceae family [8]. Benniseed is mainly cultivated in Africa, India, Sudan, China and Burma. The seeds are good source of fats, protein, carbohydrates, dietary fibre, zinc, magnesium and other minerals [8]. Sesame seeds are tiny, flat and oval with a nutty taste [9]. It is an important oil seed believed to have originated from tropical Africa with the greatest diversity [10]. Sesame seed is a staple food among many ethnic groups in Nigeria. The crop is cultivated in most areas of the middle belt and some northern states of Nigeria [11]. Sesame seed consist of oil (44-52.5%), protein (18-23.5%) and 13% of carbohydrate [12, 13]. The seeds are consumed fresh, dried or blended with sugar. It is also used as a thickener in some local soups [9]. The meal has high protein concentration which is rich in methionine and tryptophan. Since these amino acids are lacking in some other sources of vegetable proteins such as soybean, sesame seed flour can be added to recipes to provide important nutrient balance for human nutrition [14]. Supplementation of food is of current interest because of increasing nutritional awareness among consumers and it is one way to meet the protein needs especially with the help of baked foods [15].

Millet (Pennisetum typhoides) is a generic term used for small sized grains that form heterogeneous group and referred along with maize and sorghum as 'coarse cereals' [16]. Millets are important staple foods in the diets of African and Asiatic people [16]. Their agricultural uses are as a result of their hardiness, tolerance to extreme weather and their ability to grow in low rainfall areas [16]. Majority of the millets are grown in different regions of the world from east to west. The world total production of millet grains was 762712 metric tonnes with India accounting for 334500 tonnes in 2010 [17]. These crops have substantial potential in increasing diversity in the food basket and ensuring improved food and nutrition security [18]. Millet is reported to have considerably higher protein content than most other cereals, but its protein is limiting in lysine, as with other cereals [19]. Millets are rich in micronutrients such as minerals and B-vitamins and nutraceuticals. Thus this study is design to produce and determine the functional properties of various flour blends from wheat, sesame seeds and millet, produce biscuits from the various flour blends and to determine the proximate, minerals and ant-nutritional compositions of the flour blends and their biscuits. The outcome of the project will aid in boosting the nutritional value of the product and it will contribute to increasing the utilisation of millet and sesame seeds which are locally grown crops thereby reducing the over dependence of wheat importation.

2. Materials and Methods

2.1. Source of Raw Materials and Preliminary Treatments

Millet grains, sesame seeds, wheat flour, sugar, butter, baking powder and of salt were bought from Wurukum market in Makurdi, Benue State Nigeria.

2.2. Sesame Seed Flour Production

Figure 1 shows the flow chat for sesame seeds flour production. The sesame seeds purchased were de-stone, washed and Soak in clean water for 24 hours, dried in an oven at 70℃ for 1 hour after which they were been ground into fine flour, sieved using 44 mesh sieve then packaged and preserved for further use.

Sesame seeds
↓
Cleaning (De-stoned)
↓
Soaking (24 h)
↓
Roasting (70°C)
↓
Milling
↓
Sieving
↓
Sesame flour

Source; Ayinde [20]

Figure 1. *Flow chat for the production of sesame seeds flour.*

2.3. Millet Flour Production

The purchased millet grains were cleaned to remove foreign particles, washed properly and soaked for 24 hours followed by drying in an oven at 70°C for s 1 hour. The dried grains were then processed into flour using a milling machine and sieved using 44 mesh after which it was packaged and preserved for further use. As seen in figure 2.

Millet Grains
↓
Cleaning
↓
Washing
↓
Soaking (24h)
↓
Drying (70°C)
↓
Milling
↓
Sieving
↓
Millet flour

Figure 2. *Flow chat for the production millet flou.*

2.4. Recipe for Biscuits Batter from Wheat, Millet and Sesame Seeds Flour Blends

The various blend formulations from mixtures of wheat, sesame seed flour and millet flours were mixed separately with the same quantity of other ingredients (sugar, baking powder, water, baking fat and salt. For 100g of flour, 30 g fat, 33 g sucrose, 1 g salts (NaCl), 3.3g baking powder, were used. 162ml of water was added to make required consistency of batter [21]. The fat was creamed with sugar until fluffy. The other dry ingredients were added, 160ml of water was added until the desired texture of the batter was obtained. The batter was kneaded on a rolling table to acquire the desired thickness [21]. The batter was later cut into round shape with the aid of biscuit cutter. Shaped pieces were placed into a pan greased with butter and baked in the oven at 200°C for 20min after which they were cooled and packaged [21].

Table 1. *Samples of flour blends for biscuits.*

Flour blends (%)			
Samples	**Wheat**	**Millet**	**Sesame seeds**
A	100	0	0
B	90	5	5
C	85	10	5
D	80	15	5
E	75	20	5

2.5. Determination of Functional Properties of Flours

The bulk density, oil absorption capacity, foaming capacity, swelling capacity and water absorption capacity of the flour was determined using Onwukas' method [22].

2.6. Physicochemical Analyses

Proximate Analysis

2010 official method of AOAC [23] was used for proximate analysis carbohydrate was determined by difference according to the equation (5) as follows;

Carbohydrate = 100% - (%moisture +%fat +%protein +%crude fibre +%ash

Mineral Analysis

A modified AACC (Cereals and Grains Association, formerly American Association of Cereal Chemists, 2010) official inductively coupled plasma spectroscopy method 4075.01 was used for determination of Ca, Mg, Fe, Zn, Mn, As, Cu, and Pb content of flour blends and biscuits [24, 25].

Anti-nutritional analysis

Hydrogen cyanide determination was by alkaline picrate method [22], the phytate and tannins content by Hassan's method [26], Oxalate and by Dye method [27].

2.7. Statistical Analysis

Data obtained from chemical analysis and the sensory evaluation were subjected to a one-way analysis of variance (ANOVA) using SPSS version 20, statistical package in order to determine the significant difference between mean of the various parameters.

3. Results

3.1. Functional Properties of Wheat, Millet and Sesame Seeds Flour Blends

The results for the functional properties of flours are shown in Table 2. The values show significant difference in the functional properties of flours; bulk density, swelling capacity, oil absorption capacity, water absorption capacity and foaming capacity. The bulk density of wheat flour was 0.880 that for sesame seeds flour 0.576, millet flour 0.728g/cm^3. The bulk density for the flour blends ranged from 0.812 to 0.993g/cm^3. The swelling capacity of wheat flour, sesame seeds flour, and millet flour was, 1.224, 0.864 and 0.540%respectively. The highest value for swelling capacity was found in composite flour W75M20S5 (1.65%), followed by W80M15S5 (1.513%), W85M10S5 (1.424%), W100 (1.224%), and W90M5S5 (1.181%) respectively. Oil absorption capacity in the various flours was; 0.846g/l in W100%, 0.778g/l in S100%, 1.082g/l in M100%, 1.117g/l in W90M5S5, 1.358g/l in W85M10S5, 1.600g/l in W80M15S5 and 1.835g/l in W75M20S5. For water absorption capacity, M100% recorded1.44%, S100, 1.51%, M100, 1.72%, W90M5S5, 1.85%, W85M10S5, 1.99%, W80M15S5, 2.01% and W75M20S5 had 2.25% which was the highest value. W100%, M100, S100%, W90M5S5, W85M10S5, W80M15S5 and W75M20S5 recorded 8.05, 1.50, 5.07, 9.03, 9.98, 10.27, 10.87 and 11.03ml/g respectively for foaming capacity.

Table 2. *Functional properties of wheat, millet and sesame seeds composite flours.*

Functional properties	FLOUR							LSD
	W (%)	**100**	**0**	**0**	**90**	**85**	**80**	**75**
	M (%)	**0**	**0**	**100**	**5**	**10**	**15**	**20**
	S (%)	**0**	**100**	**0**	**5**	**5**	**5**	**5**
BD (g/cm^3)	0.880^{abc}±0.05		0.576^{e}±0.03	0.728^{d}±0.05	0.812^{cd}±0.03	0.846^{bcd}±0.13	0.976^{ab}±0.03	0.993^{a}±0.01	0.053
SC (%)	1.224^{ab}±0.14		0.864^{bc}±0.03	0.540^{c}±0.59	1.181^{ab}±0.03	1.424^{ab}±0.07	1.513^{a}±0.03	1.645^{a}±0.08	0.226
OAC (g/l)	0.846^{e}±0.13		0.778^{e}±0.11	1.082^{d}±0.12	1.117^{d}±0.03	1.358^{c}±0.09	1.600^{b}±0.02	1.835±0.13^{a}	0.087
WAC (ml/g)	1.444^{c}±0.19		1.510^{c}±0.03	1.724^{bc}±0.07	1.850±0.10^{b}	1.985^{ab}±0.04	2.014^{ab}±0.03	2.253^{a}±0.22	0.119
FC (%)	8.049^{e}±0.25		5.066^{f}±0.24	9.026^{d}±0.48	9.983^{c}±0.32	10.270^{bc}±0.38	10.869^{ab}±0.07	11.029^{a}±0.13	0.290

Results are means ± SD of triplicate determinations expressed on a dry weight basis. Values in each row with common superscripts are not significantly ($p > 0.05$) different.

key:

W=wheat, M=Millet, S=Sesame, W100%= 100% wheat flour, M100%= 100% millet flour, S100%=100% sesame seed flour, W100M0S0=100%wheat, millet 0%, sesame 0%, W90M5S5,=Wheat 90%, millet 5%, sesame 5%, W85M10S5=Wheat 85%, M10%, 5%, W80M15S5=Wheat 80%, millet15%, sesame 5%, W75M20S5%=Wheat 75%, millet 25%, 5% sesame

B. D =bulk density, S. C= swelling capacity, W. A. C = water absorption capacity, O. A. C = oil absorption capacity, F. C= foaming capacity.

3.2. Anti-nutritional Composition of Flours and Biscuits Blends

Tables 3 and 4 shows the anti-nutritional composition of flour blends and composite biscuits.

There was a significant difference in the HCN, phytates, oxalate and tannins content in all the flour and biscuits blends. HCN content of flour blends ranged between 0.037mg/kg to 0.086mg/kg with W75M20S5 having the highest value (0.086mg/kg) and W100% having the lowest value of 0.037 mg/kg. There was a steady increase in the phytate content of flours as the flour substitution increases from 0.064mg/kg in wheat flour to 0.556mg/kg in W75M20S5. The oxalate content in flour blends ranged from 0.317mg/kg in W100 to 0.571 in W75M20S5. The tannin value in the flour blends ranged from 3.51 to 5.03mg/kg. There was a significance difference in the HCN, phytates, oxalate and tannins content in all the biscuits samples. HCN was detected in all the biscuits samples though very minimal (<0.001). W75M20S5 composite biscuits had the highest value for phytate content 0.085mg/kg, and W100% the lowest (0.052mg/kg). Oxalate content of composite biscuits increased significantly from 0.113mg/kg in wheat flour biscuits to 0.166 mg/kg in W75M20S5 composite biscuits. Sample W75M20S5 had the highest oxalate content of 0.166mg/kg. Tannin content in biscuits samples increased significantly from 1.41mg/kg in W100%, 1.48mg/kg in W90M5S5, followed by sample W85M10S5 1.78mg/kg, sample W80M15S5 1.90 mg/kg and sample W75M20S5 2.22mg/kg. W75M20S5 in biscuits blend recorded the highest value for tannin content meanwhile 100%wheat biscuits recorded the lowest value.

Table 3. *Anti nutritional properties of wheat, millet and sesame seeds flour blends.*

Anti-nutrients (mg/kg)	FLOUR						LSD
	W (%)	100	90	85	80	75	
	M (%)	0	5	10	15	20	
	S (%)	0	5	5	5	5	
HCN		0.037 ^{d}±0.002	0.067^{c}±0.002	0.071^{bc}±0.002	0.078 ^{b}±0.003	0.086 ^{a}±0.004	0.000
PHYTATE		0.064 ^{a}±0.012	0.079 ^{a}±0.015	0.097 ^{a}±0.003	0.155 ^{a}±0.003	0.556 ^{a}±0.614	0.315
OXALATE		0.317^{d}±0.041	0.373^{cd}±0.019	0.437^{bc}±0.037	0.509 ^{ab}±0.017	0.571^{a}±0.019	0.115
TANNINS		3.505 ^{b}±0.39	4.517 ^{a}±0.23	4.794 ^{a}±0.03	4.960 ^{a}±0.02	5.025 ^{a}±0.05	0.736

Results are means ± SD of triplicate determinations expressed on a dry weight basis.
Values in each row with common superscripts are not significantly (p >0.05) different.
key: W=wheat, M=Millet, S=Sesame, W100%= 100% wheat flour, M100%= 100% millet flour, S100%=100% sesame seed flour, W100M0S0=100%wheat, millet 0%, sesame 0%, W90M5S5,=Wheat 90%, millet 5%, sesame 5%, W85M10S5=Wheat 85%, M 10%, 5%, W80M15S5=Wheat 80%, millet 15%, sesame 5%, W75M20S 5%=Wheat 75%, millet 25%, 5% sesame.

Table 4. *Anti nutritional properties of biscuits produced from wheat, millet and sesame seed flour blends.*

Anti-nutrients (mg/kg)	Biscuits						LSD
	W (%)	100	90	85	80	75	
	M (%)	0	5	10	15	20	
	S (%)	0	5	5	5	5	
HCN		<0.001^{a}	<0.001^{a}	<0.001^{a}	<0.001^{a}	<0.001^{a}	0.00
PHYTATE		0.052 ^{c}±0.008	0.062 ^{c}±0.004	0.065 ^{bc}±0.008	0.079 ^{ab}±0.004	0.085 ^{a}±0.002	0.085
OXALATE		0.113 ^{b}±0.023	0.143 ^{a}±0.006	0.150 ^{a}±0.003	0.158 ^{a}±0.003	0.166 ^{a}±0.004	0.000
TANNINS		1.411^{c}±0.03	1.483 ^{c}±0.03	1.783 ^{b}±0.12	1.901 ^{b}±0.08	2.220 ^{a}±0.09	0.089

S=Sesame, W100%= 100% wheat flour, M 100%= 100% millet flour, S100%=100% sesame seed flour, W100M0S0=100% wheat, millet 0%, sesame 0%, W90M5S5,=Wheat 90%, millet 5%, sesame 5%, W85M10S5=Wheat 85%, M10%, 5%, W80M15S5=Wheat 80%, millet 15%, sesame 5%, W75M20S 5%=Wheat 75%, millet 25%, 5% sesame.

3.3. Proximate Composition of Flour Blends and Biscuits Produced from Wheat, Millet and Sesame Seeds Flour Blends

Results of proximate composition of the wheat, sesame and millet composite flour and biscuits are shown in table 5 and 6. There was a significant different in the moisture, protein, fat, fibre, ash, carbohydrate and energy value. The results in table 5 showed that the value of moisture content in composite flour ranged from 13.30±0.05 to 14.92±0.51 g/100g. The value of protein in composite flour ranged from 9.65 ±0.13 to 16.53 ±0.09 g/100g. The value of fats in the composite flours ranged from 0.190 ±0.13 to 1.56 ±0.14 g/100g. Ash content in composite flour ranged between 3.62±0.23 to 4.62±0.13 g/100g. The value of crude fibre in the composite flour ranged from 1.09 ±0.05 to 1.59 ±0.14 g/100g. Carbohydrate value in composite flour ranged from 72.16±0.22 to 60.78±0.70g/100g and that of energy value ranged from 1397.81±1.40 to 1372.01±8.31kJ.

Results of proximate composition of wheat, millet and sesame seeds composite biscuits are shown in table. The results showed that there was a significant different in moisture, protein, fats, fibre, ash, carbohydrate and energy values. The value of moisture content in biscuits ranged between 6.85±0.23 and 8.78±0.26 g/100g. The value of protein in composite biscuit ranged from 9.00 ±0.07 to 16.18 ±0.07 g/100g. The concentration of fats in the composite biscuit produced ranged from 1.96 ±0.07 to 2.76 ±0.13 g/100g. The ash content of biscuit ranged from 2.20±0.09 to 2.97±0.01 g/100g. The value of crude fibre in the composite biscuit ranged between 1.01 ±0.01 to 1.07 ±0.01.

The carbohydrate value in biscuit ranged from 78.98 ±0.30 to 68.21±0.30 g/100g. Data on energy values of biscuits was affected by incorporation of millet and sesame seeds flour as presented on the table. There was a decreased in energy level from 1397.81 kJ to 1372.01kJ in the flour blends and 1568.02KJ in the wheat biscuits to 1536.922KJ in composite biscuits. The energy value decreased as the flour substitution increased with all samples significantly different from the other. The energy value of the biscuits decreased in the order, W100M0S0, W90M5S5, W85M10S5, W80M15S5, W75M20S5%.

Table 5. *Proximate composition of flour blends.*

Nutrients (g/100g)	FLOUR						LSD
	W (%)	100	90	85	80	75	
	M (%)	0	5	10	15	20	
	S (%)	0	5	5	5	5	
Moisture		13.295^{c}±0.05	14.027^{b}±0.02	14.566^{ab}±0.08	14.781^{a}±0.02	14.919^{a}±0.51	0.265
Protein		9.651^{e}±0.13	12.680^{d}±0.01	13.547^{c}±0.03	15.613^{b}±0.14	16.534^{a}±0.09	0.109
Fat		0.190^{c}±0.13	0.257^{c}±0.01	1.063^{b}±0.01	1.235^{b}±0.01	1.558^{a}±0.14	0.096
Ash		3.616^{c}±0.23	3.690^{c}±0.15	3.834^{bc}±0.12	4.234^{ab}±0.17	4.621^{a}±0.13	0.185
Crude Fiber		1.088^{d}±0.05	1.254^{c}±0.06	1.355^{bc}±0.09	1.489^{ab}±0.05	1.586^{a}±0.14	0.073
Carbohydrate		72.157^{a}±0.22	68.372^{b}±0.37	65.771^{c}±0.34	62.646^{d}±0.10	60.778^{e}±0.70	0.458
Energy kJ/100g)		1397.81^{a}±1.40	1388.11^{ab}±6.4	1388.0^{ab}±5.21	1376.11^{bc}±3.66	1372.01^{c}±8.31	6.351

Results are means ±SD of triplicate determinations expressed on a dry weight basis. Values in each row with common superscripts are not significantly (p >0.5) different

Key

W=wheat, M=Millet, S=Sesame, W100%= 100% wheat flour, M100%= 100% millet flour, S100%=100% sesame seed flour, W100M0S0=100%wheat, millet0%, sesame 0%, W90M5S5,=Wheat 90%, millet 5%, sesame 5%, W85M10S5=Wheat 85%, M100%, 5%, W80M15S5=Wheat80%, millet15%, sesame 5%, W75M20S 5%=Wheat 75%, millet 25%, 5%sesame.

Table 6. *Proximate composition of biscuits produced from wheat, millet and sesame seeds flour blends.*

Nutrients (g/100g)	Biscuits						LSD
	W (%)	100	90	85	80	75	
	M (%)	0	5	10	15	20	
	S (%)	0	5	5	5	5	
Moisture		6.85^{d}±0.23	7.11^{cd}±0.17	7.62^{bc}±0.11	7.88^{b}±0.32	8.78^{a}±0.26	0.829
Protein		9.00^{e}±0.07	11.63^{d}±0.02	12.52^{c}±0.71	14.2^{b}±0.12	16.18^{a}±0.07	0.376
Fat		1.96^{b}±0.07	2.55^{a}±0.04	2.62^{a}±0.04	2.66^{a}±0.09	2.76^{a}±0.13	0.363
Ash		2.20^{c}±0.09	2.64^{b}±0.07	2.69^{b}±0.05	2.90^{a}±0.09	2.97^{a}±0.01	0.257
Crude Fiber		1.01^{c}±0.01	1.05^{b}±0.0	1.07^{a}±0.02	1.07^{a}±0.01	1.09^{a}±0.01	0.00
Carbohydrate		78.98^{a}±0.30	75.02^{b}±0.28	73.49^{c}±0.92	71.25^{d}±0.39	68.21^{e}±0.30	0.577
Energy (KJ/100g)		1568.02^{a}±3.93	1567.34^{ab}±3.38	1558.89^{bc}±1.45	1551.87^{c}±5.17	1536.92^{d}±1.74	3.940

Results are means ±SD of triplicate determinations expressed on a dry weight basis. Values in each row with common superscripts are not significantly (p >0.5) different

Key

W=wheat, M=Millet, S=Sesame, W100%= 100% wheat flour, M100%= 100% millet flour, S100%=100% sesame seed flour, W100M0S0=100% wheat, millet 0%, sesame 0%, W90M5S5,=Wheat 90%, millet 5%, sesame 5%, W85M10S5=Wheat 85%, M100%, 5%, W80M15S5=Wheat 80%, millet 15%, sesame 5%, W75M20S 5%=Wheat 75%, millet 25%, 5% sesame.

3.4. Mineral Analysis for Flour Blends and Composite Biscuits Produced from Wheat Millet and Sesame Seeds

The results for the mineral composition of flour blends and composite biscuits are presented on (Tables 7 and 8). The mineral levels: calcium,, magnesium, iron, zinc, manganese, and copper in both flour blends and composites biscuits increased with increased in flour supplementation except for arsenic and lead which have a constant value of <0.001mg/100g. The level of minerals in all the flour and biscuits samples varied significantly except for Mg in the flours blend and As and Pb in both flour and biscuits samples which were not significant. The calcium content of the wheat, millet and sesame flour formulation ranged from 304.7 to 330.6 mg/100g. The highest value of Ca was recorded by M75M20S52 which was 330.6 mg/100g and the least value was recorded by sample W100 in the flour samples meanwhile the highest and lowest value in the biscuit samples was recorded by sample W75M20S5 and W100 respectively. There was no significant different in the level of magnesium in all the flour samples whereas the level of Mg in biscuits sample varied significantly with sample W75M20S5 recording the highest value of 221.7mg/100g and sample W100 recording the least value of 196.7mg/100g. Substitution with millet and sesame seed flour contributed to the increase in Mg level of the formulation. Fe levels among the flour samples decreased significantly. The levels of Fe in the wheat, millet and sesame seed flour decreased from 6.9 to 5.3 mg/100g and from 6.3 to 4.7mg/100g in biscuit sample from the control up to 20% substitution.

There was a significant decreased in the Zn content in both flour and biscuits samples. Increase in the level of millet flour decreased the concentration of zinc in the flour samples from a control value of 10.1 to 8.4mg/100g and from a control value of 9.4 to 7.0mg/100g in biscuit samples for the 20% flour substitution. There was significant increase in Mn in both the flour blend and biscuits samples with the wheat flour and wheat flour biscuits recording the least value of 2.63mg/100g and 1.8mg/100g respectively meanwhile sample W75M20S5 in both flour and biscuit samples recorded the highest value of 3.9 and 3.7mg/100g respectively. Furthermore, the Cu content in both flours and biscuits samples increased significantly from 0.02mg/100g to 0.18mg/100g in the flours and from 0.01 to 0.09mg/100g in the biscuit samples. There was no significant difference in As and Pb in both flour and biscuit samples. Looking at the results, it shows that processing affected the mineral content of the biscuit greatly. Comparing the mineral content of flour blends to that of composite biscuits shows that processing reduced the quantity of all the minerals in the biscuit except for As and Pb which were constant or the same before and after processing.

Table 7. *Mineral Composition for Flour Blends (mg/100g).*

Elements (mg/100g)	FLOUR						LSD
	W (%)	100	90	85	80	75	
	M (%)	0	5	10	15	20	
	S (%)	0	5	5	5	5	
Ca	304.7^{e}±3		311.1^{d}±2.0	314.7^{c}±3.4	323.3^{b}±8.0	330.6^{a}±2.0	0.428
Mg	281.7^{a}±3.0		286.8^{a}±3.0	291.2^{a}±4.1	294.3^{a}±4.0	299^{a}±2.0	0.00
Fe	6.9^{a}±0.2		6.07^{b}±0.1	5.8^{bc}±0.01	5.6^{cd}±0.1	5.3^{d}±0.1	0.237
Zn	10.1^{a}±0.8		9.6^{b}±0.30	9.5^{b}±0.04	8.5^{c}±.0.02	8.4^{c}±.0.01	0.298
Mn	2.63^{c}±0.3		3.1^{b}±0.4	3.5^{ab}±0.01	3.8^{a}±0.02	3.9^{a}±0.14	0.259
As	<0.001		<0.001	<0.001	<0.001	<0.001	0.00
Cu	0.02^{d}±0.01		0.05^{cd}±0.01	0.07^{bc}±0.02	0.11^{b}±0.01	0.18^{a}±0.01	0.027
Pb	<0.001		<0.001	<0.001	<0.001	<0.001	0.00

Results are means ± SD of triplicate determinations expressed on a dry weight basis. Values in each row with common superscripts are not significantly (p >0.05) different

Key

W=wheat, M=Millet, S=Sesame, W100%= 100% wheat flour, M100%= 100% millet flour, S100%=100% sesame seed flour, W100M0S0=100% wheat, millet 0%, sesame 0%, W90M5S5,=Wheat 90%, millet 5%, sesame 5%, W85M10S5=Wheat 85%, M10%, 5%, W80M15S5=Wheat 80%, millet 15%, sesame 5%, W75M20S 5%=Wheat 75%, millet 25%, 5%sesame

Ca =calcium, Mg = magnesium, Fe = iron, Zn = zinc, Mn= manganese, As= arsenic, Cu=copper, Pb= lead.

Table 8. *Mineral Composition for biscuits (mg/100g).*

Elements (mg/100g)	BUSCUIT						LSD
	W (%)	100	90	85	80	75	
	M (%)	0	5	10	15	20	
	S (%)	0	5	5	5	5	
Ca	205.0^{e}±4		213.3^{d}±5.1	224^{c}±4.4	233^{b}±4.2	246^{a}±2.0	0.756
Mg	196.7^{e}±2.0		205^{d}±7.0	213^{c} .5±3.6	218^{b} .3±6.1	221.7^{a}±3.4	0.784
Fe	6.3^{a}±0.2		5.6^{b}±0.4	5.3^{bc}±0.1	5.1^{cd}±0.2	4.7^{d}±0.2	0.307
Zn	9.4^{a}±0.11		9.13^{a}±0.13	8.6^{b}±0.12	7.9^{c}±.0.3	7^{d}±.0.17	0.259
Mn	1.8^{d}±0.12		2.4^{c}±0.4	2.7^{c}±0.11	3.2^{b}±0.03	3.7^{a}±0.14	0.298
As	<0.001		<0.001	<0.001	<0.001	<0.001	0.00
Cu	0.01^{c}±0.01		0.03^{bc}±0.01	0.05^{abc}±0.02	0.07^{ab}±0.01	0.09^{a}±0.01	0.025
Pb	<0.001		<0.001	<0.001	<0.001	<0.001	0.00

Results are means ± SD of triplicate determinations expressed on a dry weight basis. Values in each row with common superscripts are not significantly (p >0.05) different

Key

W=wheat, M=Millet, S=Sesame, W100%= 100% wheat flour, M100%= 100% millet flour, S100%=100% sesame seed flour, W100M0S0=100% wheat, millet 0%, sesame 0%, W90M5S5,=Wheat 90%, millet 5%, sesame 5%, W85M10S5=Wheat 85%, M10%, 5%, W80M15S5=Wheat 80%, millet 15%, sesame 5%, W75M20S 5%=Wheat 75%, millet 25%, 5% sesame

Ca =calcium, Mg = magnesium, Fe = iron, Zn = zinc, Mn= manganese, As= arsenic, Cu=copper, Pb= lead.

4. Discussion

The term "functional property" is defined as any property aside from nutritional attributes that influences the ingredient's usefulness in food. Most functional properties play a major role in the physical behaviour of foods or food ingredients during their preparation, Processing, or storage [28]. The functional properties of flours play important role in the manufacturing of different types of products. The composite flours, millet flour, sesame seeds flour and wheat flour were analysed for their functional properties. The Water absorption capacity (WAC) of flour has an important role in the food product preparation process as it influences other functional and sensory properties. The water absorption capacity of composite flours (CF) was found to be within the range 1.44 ml/g to 2.25ml/g. Increase in the WAC of composite flours can be attributed to higher carbohydrate content in wheat and millet flours. Optimum water intake of composite flour (CF) was found to be 2.25ml/g in W75M20S5 whereas 1.44ml/g in case of wheat flour. Bulk density of composite flour was found to be in the range 0.63 to 0.68 g/cm^3 whereas in case of wheat flour 0.81g/cm^3. The increase in bulk density as the quantity of millet was increasing in the flour blends may be due to the presence of more crude fibre in millet flour in accordance with the observation made by Singh *et al.*[28]. Bulk density is generally affected by the particle size and the density of the flour and it is very important in determining the packaging requirement, material handling and application in wet processing in the food industry. The swelling capacity (SC) of composite flours ranged from 1.224 to 1.65%. The highest value of swelling capacity was found in composite flour W75M20S5 (1.65%), followed by W80M15S5 (1.513%), W85M10S5 (1.424%) and W100 (1.224%). The swelling capacity of composite flours depends on size of particles and types of processing methods. Foam capacity of composite flours ranged from 8.05% to 11.03%. Highest foam capacity was observed in W75M20S5, followed by W80M15S5 (10.87%), W85M10S5 (10.27%), W90M5S5 (9.98%), M100 (9.03) and the lowest S100% (5.07%). Foam is a colloidal of many gas bubbles trapped in a liquid or solid. Foam formation and stability generally depend on the interfacial film formed by proteins which keeps air bubbles in suspension and slows down the rate of coalescence [29]. Foam capacity of composite flours was increased with increasing in the blending ratio of millet flours. The result of study showed that the decreasing in the proportions of wheat flour increased the foam capacity of the composite flours. Similar results were found by [28]. Oil absorption capacity of any food is important because it relies on its capacity to entrap oil by a complex capillary attraction process. The ability of a food component to entrap oil is a good characteristic because oil acts as a flavour enhancer, a consistency trait and an important enhancer of mouth feel [30]. Millet flour sample showed a higher oil absorption capacity than other flours. Sample S100 had the lowest oil absorption capacity.

The presence of anti-nutrients in foods could hinder the efficient utilization, absorption or digestion of some nutrients and thus, reduce their bioavailability [31]. The anti-nutrient contents in composites flours and composites biscuits are shown in table. The hydrogen cyanide (HCN) content in both composite flours was minimal (<0.001). HCN in flour samples ranged from 0.037 to 0.086mg/100g and in biscuits from 0.00036 to 0.00067mg/kg. This was in agreement according to Standard Organisation of Nigria (SON) 1992 which states that the HCN for biscuits should be 0.03mg/100g maximum. The wheat flour sample had the lowest HCN content of 0.037mg/100g, phytates (0.064mg/100g), oxalate (0.317mg/100g), and tannins 3.51mg/100g. The same trend was observed in wheat flour biscuits having very low levels of HCN (0.00036mg/100g), phytate (0.052mg/100g), oxalate (0.113mg/100g) and tannin (1.41mg/100g). Similar low levels of tannin (0.28%), oxalate (0.51%), phytate (4.5 x 10^{-5}%) and cyanide (8.0 x 10^{-5}%) had been reported by [31] in BITA3 green banana hybrid. The highest amount of oxalate was recorded in sample W75M20S5 (0.571mg/100g) for flour blends and for biscuits samples, W75M20S5 (0.166mg/100g) recorded the highest value, followed by sample W80M15S5 (0.158mg/100g) whereas the lowest amount was recorded in W100M0S0 (0.113mg/100g). High oxalate content in food causes kidney stones, these values were less than a value of 0.51 to 1.05% reported by [32] on cookies made from wheat flour and germinated sesame. Tannin content in the flour samples ranged from 3.51 to 5.03 mg /100 whereas that in biscuits samples ranged from 1.41 to 2.22 mg/kg. Tannin-protein complexes may cause protein digestibility reduction and digestive enzymes inactivation caused by protein substrate and ionisable iron interaction [33].

The proximate results of both flour blends and biscuits blends revealed that increase in millet flour substitution caused a significant increase in moisture, protein, fat, crude fibre, ash and decrease in carbohydrate and energy contents in both biscuits and flour blends. This might be so because of the higher levels of protein, fat, fibre and minerals, as well as the lower carbohydrate content of millet and sesame as compared to wheat flour. A similar result was reported when Protein–Rich biscuits were produced from blends of wheat and defatted Sesame flours by Gernah and Anyam [34]. Proteins are essential constituents of all body tissues which help the body to produce new tissues. They are very important during growth, pregnancy and when recovering from wounds. Fats, especially the unsaturated type found in sesame [35] apart from being a source of energy also provide other important nutritional benefits to the body. Recently, awareness of the importance of consuming dietary fibre has increased owing to its implication in the reduction of blood cholesterol levels and incidence of cancer [36]. Dietary fibre is the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the small intestine, with partial fermentation in the large intestine. Ash content indicates the availability of minerals, which help to keep the body alkaline and are very essential in the normal functioning of the body since they are involved in many biochemical processes.

The proximate composition values recorded from all the biscuit samples falls within the range with the requirements given by the Standard Organization Of Nigeria (SON) 1992. Recommended level for parameters for biscuits according to SON are; moisture (%w/w) =6.0 (max), ash (%w/w)=2.0 (max), acidity of extracted fat (%w/w)=1.0 (max), protein% (N×5.7)= 5.0 (min). Biscuits produced from wheat, millet, and sesame seeds flour blends have higher values of moisture, protein, fats, ash and crude fibre content than biscuits produced from 100% wheat flour. This was also observed in the wheat, millet and sesame composite flours. The addition of sesame seeds flour in the recipe increased the protein, fats and moisture contents of the biscuits and flour since sesame seeds is known to contain high level of protein and fats [37]. These results are in line with the work of; [32] which stated that sesame seeds are high in protein and oil content [18]. The results showed that there was a significant difference in moisture, protein, fibre, ash, carbohydrates and energy value of biscuit samples. Although biscuit produced from composite flour had higher values of ash and crude fibre, this may be as a result of the impact of millet and sesame seed flour on the mineral level of biscuits blend [38]. This showed that addition of millet and sesame seeds may enhance the amount of mineral intake in the food product [39] and as such would contribute dietary amounts of mineral. Sesame and millet have higher level of crude fibre than wheat flour [38, 37]; this was shown in the quantity of crude fibre that was recorded in the biscuits produced from wheat, millet and sesame seeds flour blends. The crude fibre values recorded from both flour samples and all the biscuit samples are within the recommended level of ≤ 6g/100g [40]. Biscuits produced from 100% wheat flour were significantly different in moisture, fat, ash content from biscuits produced from different proportion of wheat, millet and sesame seeds flour blends. The increase in moisture content in composite flours could be as a result of increased protein level from sesame seeds and millet flour addition; because proteins especially from cereals have been observed to have high affinity for moisture and would absorb increasing amount of moisture if available [41, 19]. 100% wheat flour and biscuits produced from it recorded the highest carbohydrate and energy values. Also, the increase in protein, ash, fat, and crude fibre contents of biscuit produced from wheat, millet sesame seeds flour blends could be as a result of sesame seeds flour addition, because previous studies reported that sesame seeds flour contains higher amounts of protein, ash, fat and crude fibre than wheat flour [42]. The steady increase in fats content of biscuit samples with increasing millet flour proportion might be due to the fact that millet flour has high affinity for oil absorption. The increased fibre content of both composite flours and biscuits has several health benefits, as it will aid digestion in the colon and reduce constipation often associated with whole wheat biscuit. The carbohydrate content of flour samples ranged from 72.16 to 60.78g/100g and that of biscuit samples ranged from 78.98 to 68.21g/100g. This shows that the snacks are good sources of energy needed for normal body metabolism. The energy value of flour samples ranged from 1397.81kJ to 1372.01kJ and in the biscuit samples it ranged from 1568.02 to 1536.92kJ. Energy content of food is essential in dealing with problems associated with normal nutrition, under nutrition and obesity.

The mineral levels (Calcium, Magnesium and Manganese) of the biscuits produced from wheat, millet and sesame seeds flour blends were higher than that produced from 100% wheat flour. The same results were observed from the analysis of flour blends. These results can be compared to that of [37] who had similar results in their work on nutritional and organoleptic properties of wheat and sesame seeds composite flour baked food [37]. The increase in mineral content of biscuit produced from wheat, millet and sesame seeds composite flour compared to 100% wheat flour biscuits is because sesame seeds which is one of the component of the composite flour used in producing the composite biscuits is packed with a lot of nutrients [1]. It was reported by [43] that calcium is a micronutrient essential to health and well-being, which performs diverse biological function in the human body. It serves as a second messenger for nearly every biological process, stabilizes many protein and in deficient amounts is associated with a large number of disease. Calcium is reported to be essential for blood clotting, bone and teeth formation and as a co-factor in some enzyme catalysis [44].

Pathak & Kapil [45] reported that zinc is vital in protein synthesis, cellular differentiation and replication, immunity and sexual functions. In humans, magnesium is required in the plasma and extracellular fluid, where it helps maintain osmotic equilibrium [46]. It can also prevent some heart disorders and lower blood pressure in humans. Iron facilitates the oxidation of biomolecules to control obesity, which predisposes an individual to various diseases. It is also essential for hemoglobin formation [46]. The As, and Pb values were the same in both flour and biscuits samples (<0.001mg/100g). There was no significant different between them. The Cu levels in flour and biscuit samples increased significantly and according to the results, it shows that processing reduced the Cu level in the biscuits. The As, Cu, and Pb values for both flour samples and biscuit samples were within the range as stated by Standard Organisation Of Nigeria (SON) 1992 which stated that maximum levels of As, Cu, and Pb in biscuits should be 1mg/kg, 2mg/kg and 2mg/kg respectively.

5. Conclusion

Biscuits are an important baked product in human diet and are usually eaten with tea and are also weaning food for infants. Wheat flour is a common source of fibre, protein, calcium, iron and other minerals like selenium. Sesame seed are an excellent source of copper, a good source of manganese and a good source of magnesium, calcium, and selenium, fibre, unsaturated fatty acids and proteins. As such, these products can be utilized to develop more value added products hence making its more economical and affordable for the developing countries without compromising the nutritional quality. Biscuits produced from composite flour of wheat, sesame seeds and millet measured very well in proximate, minerals, anti-nutrients, yeast and mould with biscuits produced from 100% wheat flour. The composite biscuits contain higher protein content, fibre content, fat content, mineral content than biscuits produced from 100% wheat flour. Therefore; biscuit produced from composite flour have added functionality which gives the biscuit the potentials that will help it to reduce cases of malnutrition and other diseases that are rampant in some African countries. Millet and sesame seeds flour could be useful in the production of highly nutritious biscuits.

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