Bioactive compound, chemicals properties, physical and sensory properties of biscuit produced from defatted sesame seed flour and unripe plantain flour blend

ABSTRACT

This study attempts to investigate Biscuit Produced from Defatted Sesame Seed Flour and Unripe Plantain flour Blend were evaluate for Proximate composition, Antioxidant property, Mineral compositions, Sensory and Physical Properties. Composite flour formulation comprising varying proportions of defatted sesame flour and unripe plantain flour blends (100:0, 90:10, 80:20, 70:30, 60:40 and 50:50). The biscuit were produced from the composite flour blends with other ingredients (fat, sugar, baking powder and salt). The crude fiber, protein content, moisture content, ash content, fat content and the carbohydrate content range from (21.95% to 29.1%), (7.07% to 23.05%), (1.98% to 9.98%), (3.63% to 4.23%), (34.75% to 44.51%) and (6.37% to 11.50%) respectively. The antioxidant property (DDPH scavenging radical) ranges from 31.34% to 79.69% respectively. The mineral composition calcium (Ca) and iron (Fe) ranges from 1.93 to 2.23mg/kg and 0.78 to 3.78mg/kg respectively. The physical properties; thickness, diameter, weight and spread ratio ranges from (0.96cm to 1.24cm), (4.85 to 5.06cm), (6.93g to 7.57g) and (4.56 to 5.43cm) of the biscuit. The sensory acceptability of the biscuit had a mean score that was generally acceptable for sample 80:20. The unripe plantain flour had a significant effect and contributed to the flour blend and the biscuit properties.

Keywords: Proximate composition, Antioxidant property (DPPH), Mineral compositions, and Sensory properties

1. INTRODUCTION

Biscuits are one of the most popular bakery products, mostly made from cereal consumed by nearly all people in the world (Nyadroh *et al.,* 2021). Biscuits are ready-to-eat, convenient and inexpensive baked product, containing digestive and dietary fibers, which are vital to the human body (Nyadroh *et al.,* 2021). The major ingredients in biscuit production include flour, fat, sugar and water. Other ingredients added are either optional or added to give a desired sensory attribute.

Biscuits are rich source of fat and carbohydrate, good source of protein and minerals (Sudah *et al*., 2007). They represent a fast growing segment of food because of consumer demands for convenient and nutritious food products. The consumer demand has increased for the quality food products with taste, safety, convenience and nutrition (Sudah *et al*., 2007). There are hard dough biscuits and soft dough biscuits. Hard dough biscuits contain relatively low levels of fat and sugars with large amount of water added during dough formation stage (mixing). Soft dough biscuits on the other hand contains relatively high levels of fat and sugar with little amount of water added during the dough formation stage (mixing) (Idoko, 2013).

Sesame seed (*Sesame indicum* L.) from the family of *Pedaliacea* is an important oil seed legume, which is cultivated in many tropical, subtropical temperate area of the world, and it is called benne seed (Anon, 2012). Is a rich plant based protein crop. It is mostly cultivated for his low cholesterol as dietary oil for specific medical cases such cardiovascular diseases. Sesame seed contain vitamin which is an antioxidant and enhanced vitamin K activity is said to prevent cancer and heart disease. Sesame seed have a characterized nutty and slightly sweet flavour could complement the flat, bland taste of wheat to produce biscuits that are more acceptable (Gernah, 2014).

Sesame seed is composed of 50% of fat and 20% protein. Proximate composition of sesame seed are 15.6-29.05% carbohydrate, 1.44-5.93% ash, 3.25-11.27% protein, and 0.22-3.5% moisture (Nweke, *et al*., 2011). Sesame seed is composed of about 47.8-52.2% oil, 25.8-26.9% protein and 4.7-5.6% ash (Gandhi, 2008).

Sesame seed contains vitamin K, vitamin E that is an antioxidant and lecithin, which promote good cardiovascular function among the many beneficial vitamins for maintaining good health. Oil is it largest constituent and it is a rich plant based protein with characterized aroma and taste of mild and nut like, the seed is rich with thiamin and vitamin B_6 (Nweke, *et al*., 2011).

Sesame seed was reported to be rich in protein (with high levels of methionine and moderate levels of lysine), vitamins, minerals and unsaturated fatty acids (Gernah, 2008) would make an excellent protein complement to other plant proteins.

Defatting is required in the case of leguminous oil seeds such as sesame seed when protein-rich, stable flours are required. Although full fat flours are more energy dense than fully or partially defatted flours, they have lower protein content and are prone to hydrolytic and oxidative rancidity (Kumar *et al.,* 2017).

Dry heating of sesame seed prior to dehulling disrupts fat bodies, thereby allowing oil to be readily expelled from the lipid bodies during the defatting step. Ethanol and other solvent such as petroleum ether, because they are clear odourless liquid that have high evaporating rate (330kJ/kg), simple recovery and non- polar solvent (Kumar *et al.*, 2017).

Defatted sesame seed flour is gluten-free flour, rich in minerals, made from fat-reduced sesame seeds (or defatted sesame seed). This flour has a fine, white appearance, yet contains some 15% fibre and as much as 46% protein. Sesame flour also includes ample minerals and vitamins. 75 grams of sesame flour will fully cover the recommended daily intake of magnesium and zinc. It also provides calcium and vitamin E (Gernah, 2014).

Defatted sesame seed (*Sesame indicum*) flour contains protein (55.7%), ash (9.83%), crude fiber (1.64%) and carbohydrate (29.40%) and is high in sulphur containing amino acids. It is widely used in baking and confectionary products. They are the affluent source of protein, carbohydrates, dietary fiber, zinc, magnesium, and many other minerals (Prakash, 2014).

Unripe plantain (*Musa paradisiaca*) also called green plantain is a major food crop grown in humid and sub humid part of Africa. They belong to the family of *Musaceae* (Adepoju *et al*., 2012). Plantain is a starchy staple food found around in Sub-Sahara Africa, providing more than 25% of the carbohydrate and 10% of the daily calorie intake for more than 70 million people in the continent (Kayode, *et al*., 2013).

Plantains are incredibly rich in antioxidants. Antioxidants are compounds that help fight free radicals that cause oxidative damage in the body. One study found that the peels and flesh of plantains contain flavonoids and polyphenols – two important antioxidants. Antioxidants are important because they help fight metabolic disorders like diabetes, cancer, and heart disease (Obidike, 2021). Unripe plantains are high in resistant starch, which gives them a low glycemic index (GI) of 45 when boiled. Resistant starch is a type of carbohydrate that does not break down into sugar in the small intestine but passes into the large intestine where fermentation occurs. Because resistant starch is not digested in the small intestine, it does not raise blood glucose levels, making it an ideal food for diabetes. Additionally, fermentation in the large intestine improves glycemic control by promoting the growth of "good" gut bacteria (Obidike, 2021).

Nutritionally, unripe plantain (*Musa paradisca*) flour constitute a rich energy source with carbohydrate accounting for 22-32 % of the fruit weight for banana and plantain respectively and also rich in vitamins A, B_6, C, dietary fibre, iron potassium and calcium (Adeniji *et al.*, 2007). Unripe plantain flour contains high resistant starch content. Although, they are starchier than banana and their carbohydrate content consist of a type of fibre that is resistant to starch (Obidike, 2021). From the health benefits of defatted sesame flour and unripe plantain flour, their incorporation as composite blends in the preparation of biscuit may enhance the nutritional and health status of the consumers and reduce total dependence on wheat flour (Sodipo *et al.*, 2021).

Baking temperature informs the baker the appropriate temperature in which baking of the biscuit should alongside the required time although different factors affect baking temperature and time therefore only ranges can be put forward to suggest the baking temperature and time for baked product. Biscuit usually have a baking a temperature range of 175^{o}C at 15 to 20 minutes (Deepshikha, 2017). Based on the work of Deepshikha, (2017) the range in time was due to the time it takes for colour formation of the final product.

2.0 MATERIALS AND METHODS

2.1 MATERIALS

Sesame seed (*Sesamum indicum*), unripe matured plantain (*Musa paradisca*), margarine (fat), baking powder, salt and sugar were all purchased in New Market Wukari, Taraba State.

2.2 METHODS

2.2.1 Raw material Preparation

The preparation of the raw material that will be used in the production of biscuit alongside the various flow charts showing their unit operation with their sequential production process involved in the final product, which is the biscuit.

2.2.1.1 Defatted sesame flour preparation

Sesame seeds were sorted to remove bad seeds and other foreign materials. The seeds were soaked overnight in cold tap water at ambient temperature and the hulls completely removed by floatation technique through hand rubbing (Chinma *et al*., 2012).

The dehulled seeds were dried under the sun and milled into flour using attrition mill to obtain the full fat sesame flour. Full fat sesame flour was poured in a white muslin cloth and immersed in transparent plastic bucket with a cover containing ethanol for 24 hour to extract the oil. The meal was air dried for 72 hour and milled. The flour was passed through a sieve and packaged as shown in figure 1 (Ahemen *et al*., 2018).

Sesame seeds
↓
Sorting
↓
Cleaning
↓
Soaking
↓
Dehulling
↓
Drying for 24h
↓
Milling
↓
Oil extraction
↓
Drying for 72h
↓
Refining
↓
Defatted Sesame flour

Figure 1: Flow chart of processed defatted sesame flour modified method of (Ahemen *et al*., 2018).

2.2.2.2 Unripe plantain flour preparation

The flour was prepared using method described by (Kiin-Kabari, 2013). Plantain fingers were washed, and then water blanched for 5 to 10 min. After blanching, it was water cooled for some before it was peeled manually with the aid of stainless steel kitchen knife and the pulp was cut into uniform slices, drained, and dried in air circulating oven at 65℃ for 20h. The dried plantain pulp were milled into fine powder flour and sieved for even size distribution, packaged in polyethylene container as shown in figure 2.

Unripe matured plantain
↓
Washing
↓
Blanching for 15 minutes
↓
Peeling
↓
Slicing
↓
Drying
↓
Milling
↓
Sieving
↓
Plantain Flour

Figure 2: Flow diagram of preparation of plantain flour modified method of (Kiin-Kabari, 2013)

2.2.2 Composite flour formulation

Composite flour formulation comprising varying proportions of defatted sesame flour and unripe plantain flour blends (100:0, 90:10, 80:20, 70:30, 60:40 and 50:50) were prepared by mixing required amounts of respective flours. The composite flour was formulated in different ratios with defatted sesame flour being the highest (control) shown in Table 1. The composite mixtures in this study were 100% defatted sesame seed flour (100), 90% defatted sesame flour and 10% plantain flour (90:10), 80% defatted sesame flour and 20% plantain flour (80:20), 70% defatted sesame flour and 30% plantain flour (70:30), 60% defatted sesame flour and 40% plantain flour (60:40) and 50% defatted sesame flour and 50% plantain flour (50:50). The formulation uses completely randomized design (CRD).

TABLE 1. COMPOSITE FLOUR FORMULATIONS

Sample code %	Defatted sesame flour (%)	Unripe plantain flour (%)
100	100	0
90:10	90	10
80:20	80	20
70:30	70	30
60:40	60	40
50:50	50	50

Key:

100%= 100% defatted sesame seed flour blend,

90:10= 90% defatted sesame flour and 10% plantain flour blend,

80:20= 80% defatted sesame flour and 20% plantain flour blend,

70:30= 70% defatted sesame flour and 30% plantain flour blend,

60:40= 60% defatted sesame flour and 40% plantain flour blend and

50:50= 50% defatted sesame flour and 50% plantain flour blend.

TABLE 2. RECIPE FORMULATIONS FOR BISCUIT PRODUCTION

Sample code (%)	Defatted sesame flour (%)	Unripe plantain flour (%)	Margarine/ fat (%)	Sugar (%)	Baking powder (%)	Salt (%)
100	100	0	50	40	1.6	1
90:10	90	10	50	40	1.6	1
80:20	80	20	50	40	1.6	1
70:30	70	30	50	40	1.6	1
60:40	60	40	50	40	1.6	1
50:50	50	50	50	40	1.6	1

Key:

100%= 100% defatted sesame seed flour blend,

90:10= 90% defatted sesame flour and 10% plantain flour blend,

80:20= 80% defatted sesame flour and 20% plantain flour blend,

70:30= 70% defatted sesame flour and 30% plantain flour blend,

60:40= 60% defatted sesame flour and 40% plantain flour blend and

50:50= 50% defatted sesame flour and 50% plantain flour blend.

2.2.3 Biscuit Preparation

Defatted sesame and unripe plantain flour blends were formulated as shown in Table 3, with defatted sesame flour (100%) serving as control. The biscuit were prepared according to modified method of (Gernah, 2014) shown in Table 2, a digital electronic weighing balance was used for the weighing of ingredients and mixing was done manually. Creaming of sugar and fat until it was fluffy. The flour by their proportion and baking powder were added and manually mixed in a bowl to form dough. The dough was then kneaded with a rolling pin to a uniform thickness on a kneading table and cut to a uniform diameter using a cutter/knife and baked in an oven at 160-180°C for 20 minutes. The biscuits were then removed from the oven, allowed to cool on a tray, and packaged in polyethylene (low-density) bags and stored in lidded plastic containers at room temperature.

Sesame seed and unripe plantain flour blends

↓

Creaming (fat and sugar)

↓

Mixing

↓

Dough

↓

Kneading

↓

Rolling/cutting

↓

Tray greasing

↓

Baking (160-180°C for 20 minutes)

↓

Biscuit

↓

Packaging

Figure 3 Flowchart showing the production of biscuit modified method of (Agu, 2014)

2.3 ANALYSES

2.3.1 Determination of Physical Quality of the Biscuit

The physical qualities of the biscuit were determined by various method listed below under designated headings.

2.3.1.1 Determination of diameter and thickness of the biscuit

The thickness was determined by using a Venire caliper to measure diameter of the edges of four biscuit samples. An average of the samples were calculated and reported by in millimeter by modified method of (Bala *et al*., 2015).

2.3.1.2 Determination of weight of the biscuit

The weight of the biscuit was determined by modified method of (Adeola, 2018). Samples of four (4) individual set were measured on an analytical weighing balance and their average was taken and reported in grams.

2.3.1.3 Determination of break strength

The break strength of the biscuit was determined by modified method of (Adeola, 2018). Biscuit of known thickness was placed centrally between two parallel metal bars (3 cm apart). The weights were added on the biscuit until the biscuit snapped. The accumulation weight that caused the breaking of the biscuit was regarded as the break strength of the biscuit.

2.3.2 Proximate analysis

The proximate composition of the biscuit made from defatted sesame flour and unripe plantain flour blends was determined by AOAC (Association of Official, Analytical Chemists) procedures.

2.3.2.1 Determination of ash content

Method described by AOAC international (2012) was used. Sample of 5g was weighed into a tared crucible. Crucibles was placed in a cool muffle furnace, and the furnace was ignited for 12–18h (or overnight) at about 550°C (safety tongs were used to transfer it into the muffle furnance). The muffle furnace was opened till it drops to at least 250°C, preferably lower and the samples were taken out from the furnace, Safety tongs, were used to quickly transfer crucibles to the desiccator and allow for some while to cool prior to weighing in other to obtain the ash content through calculation.

$$\text{Ash} = \frac{(\text{wt of crucible} + \text{ ash}) - \text{wt of empty crucible}}{(wt\ of\ crucible + \ sample) - wt\ of\ empty\ crucible} \times 100$$

Where Wt = weight of sample/spread

2.3.2.2 Determination of moisture content

The hot oven method as described by AOAC (2012) was employed. 100 grams of each sample was weighed out into porcelin dishes, it was put inside an oven at 100^{0}c for 4hr, and was removed, cooled in a dessicator and weighed. The drying and weighing was repeated until a constant weight was obtained. The percentage moisture was calculated from the weight loss of the dishes and sample.

$$\%\ \text{Moisture} = \frac{\text{weight of sample and dish before} - \text{weight of sample and dish after drying}}{\text{Intial weight of sample}} \times 100$$

2.3.2.3 Determination of protein

Kjeldah method (AOAC international, 2012). Solid foods are ground to pass a 20-mesh screen. Samples for analysis are homogenized. 100g of the sample (accurately weighed) in a Kjeldahl flask. Few grams of anhydrous sodium sulphate, 1g of hydrared cupric was added as (catalyst) to each sample to digest until clear to get complete breakdown of all organic matter. 10ml of concentrated sulphuric acid was added to the flask and heated until a colourless solution is obtained. The solution made up of a 100ml volumetric flask. The kjeldahl distillation apparatus was positioned by allowing the tip to be about 2cm inside the digested sample. About 5ml 0f 60% NaOH solution was added through a funnel stopcock. On the introduction of steam into the distillation apparatus NH_3 was liberated, condensed, collected, in a receiver flask containing 4% boric acid and mixture of methyl red blue as an indicator. As NH_3 drops in the beaker containing the mixture of borate and methyl red and blue, the purple coloration of the mixture changed to yellow green the characteristic of alkaline gas (NH_3). There was a quantitative analysis of the distillate by titration, it distillated to faint pink color with 0.011NHCL.

$$\% \text{ N} = \text{ NHCl} \times \frac{Corrected\ acid\ volume}{g\ of sample} \times \frac{14gN}{mol} \times 100$$

2.3.2.4 Determination of crude fiber

The determination of crude fiber was done by using a modified AOAC method, (2012). About 2g of each sample was boiled in sulphuric acid, filtered with a vacuum pump and boiled again in sodium hydroxide and then filtered. The residue was rinsed with acid (HCl) methylated spirit and weighed once more. The ash obtained was cooled and weighed. The percentage crude fibre was collected using the expression below.

$$\% \text{ Crude fibre } = \frac{\text{Loss in weight after drying}}{\text{Weight of original sample}} \times 100$$

2.3.2.5 Determination of carbohydrate

Carbohydrate content was determined by difference method, the summation of all the proximate values was subtracted from 100%.

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

2.3.3 Determination of Minerals

2.3.3.1 Determination of iron (Fe)

Spectrophotometer method used by Anon, (2012). Five test tubes are prepared and 2.5 ml of 0.1 M KSCN were added to each test tube and mixed thoroughly and 2.5g of sample is placed on a crucible and heated on a hot burner flame till it becomes ash and allowed to cool and the sample ash was transferred into a small beaker and 10 ml of 2.0 M HCl was added and carefully stirred for one minute, alongside 10 ml of distilled water. The mixture is filtered and 2.5 ml of 0.1 M KSCN was added and mixed properly. A spectrometer having a wavelength 485 nm on the UV-VIS was used to find the absorption and the necessary calculations done.

2.3.3.2 Determination of calcium (Ca)

Titrimetry method as described by (Lawani *et al*., 2014). 5.0g of sample was placed inside an 8ml of concentrated sulphuric acid and 10 ml of concentrated nitric acid into a heat-resistant beaker. 2 cm^3 aliquot of concentrated nitric acid was constantly added at any time the solution began to darken. The solution was cooled with about 10 mL of distilled water and evaporated to fuming again, and then the solution was made up to mark in 100 mL volumetric flask. 25 ml aliquot of sample digest was pipetted into a beaker and 1M NaOH solution was added to it. Two drops of solo chrome dark blue was then added and immediately titrated against a 0.01M EDTA solution to the blue end-point.

2.3.4 Determination of Antioxidant Property (DPPH)

Method described by (Bouaziz, 2010) was employed. 3.9 ml of DPPH solution (0.075 mm in methanol) will be added to 0.1 ml of properly diluted grain extracts followed by 30 min incubation in dark and absorbance and will be read at 515 nm using a Pharmacia UV spectrophotometer. A standard curve will be prepared at different concentrations (10, 25, 50, 75 and 100 lg/ml) of ascorbic acid (Sig-ma–Aldrich). The reduction in the absorbance of DPPH solution at different concentrations of ascorbic acid over a period of 30 min will be measured and plotted. The DPPH radical scavenging activities of grain extracts will be expressed in ascorbic acid equivalent antioxidant capacity. The antioxidant activity will be calculated as percent inhibition caused by the hydrogen donor activity of each sample:

$$\text{Inhibtion (\%)} = \frac{\text{Absorbance of control} - \text{absorbance of sample}}{\text{Absorbance of control}} \times 100$$

2.3.5 Determination of Sensory Properties

Panelists of 25 members comprising of students of the Department of Food Science and Technology Federal University Wukari and students from Federal University Wukari, Taraba State, to evaluated the sensory properties of the biscuit. The panelists were asked to rate each sensory attribute using the control biscuit as the basis for evaluation of surface color, appearance, texture, taste/flavor, interior color and overall quality on a 9-point hedonic scale (nine. Like extremely, eight. Like very much, seven. Like moderately, six. Like slightly, five. Neither like nor dislike, four. Dislike slightly, three. Dislike moderately, two. Dislike very much, one. Dislike extremely). Water was provided to rinse the mouth between evaluations. Biscuit samples were coded with letters and served to the panelists at random to avoid any bias.

2.4 STATISTICAL ANALYSIS

The results obtained were presented as mean ± standard deviation (SD) of duplicate measurements of variance (One Way-ANOVA) and the data were analyzed using SPSS (Software package for Social science) version 26 software. Statistical significance at 95% confidence limit ($p \leq 0.05$) was accepted, while the mean was separated using us Duncan's Multiple Range Test (DMRT).

3.0 RESULTS AND DISCUSSION

The result of the proximate composition of biscuit produced from defatted sesame seed and unripe plantain flour blend as shown in Table 3.

The result of crude fiber content shows a range from 21.95% to 29.15% respectively. The samples ratio decreases: 29.15% (80:20), 27.45% (60:40), 27.25% (50:50), 24.35% (100%), 23.95% (70:30) and 3.63% (90:10). 29.15% (80:20) has the highest fiber content which may be because the fiber content may be because unripe plantain and sesame seed are good source of fiber, which help in easy digestion and bowel removal according to (Agu, 2014). The variation down the column for the fiber might be due to biochemical reactions during baking because of the humidity in the heating chamber and the different variation of temperature for a preset temperature during baking in accordance to (Rao, 2017). The crude fiber content had a significant difference ($P \leq 0.05$) for the various samples.

The protein content ranges from 7.07% to 23.05% respectively. The samples ratio decreases: 23.05% (100%), 19.12% (60:40), 19.00% (50:50), 16.42% (70:30), 11.48% (90:10) and 7.07% (80:20). 23.05% (100%) has the highest content of protein due the fact that sesame seed is a good plant based protein supplement in different food classification according to (Agu, 2014). During baking denaturing of protein, occurs because of the baking temperature and Mailard reactions, in which amino acid react with starch sugar during baking. In biscuit production, the protein content ranges from 14% to 20% greatly increase flours susceptibility to water adsorption in accordance to (Laguna *et al.*, 2011). Protein helps in the repair of worn out tissues and cells according to (Agu, 2014). The protein content shows a significant difference ($P \leq 0.05$) for the various samples.

The result of the moisture contents shown in Table 3 range from 1.98% to 9.98% respectively. The samples ratio decreases: 9.98(90:10), 5.15(80:20), 2.00(60:40), 1.99(70:30), 1.99 (100%) and 1.98 (50:50). 9.98% (90:10) has the highest content of moisture. Moisture content variation may be due humidity in the heating chamber and external factor because of moisture from the atmosphere as a result during cooling after baking according to (Rao, 2017). The moisture content shows a significant difference ($P \leq 0.05$) for the various samples.

TABLE 3. PROXIMATE COMPOSITIONS (%)

Sample (%)	Crude fiber	Crude protein	Moisture content	Ash	Fat	Carbohydrate
100	$24.35^{c}\pm0.07$	$23.05^{a}\pm0.07$	$1.99^{c}\pm0.01$	$3.63^{c}\pm0.07$	$44.51^{a}\pm0.07$	$2.47^{d}\pm0.30$
90:10	$21.95^{e}\pm0.07$	$11.48^{d}\pm0.04$	$9.98^{a}\pm0.04$	$3.89^{b}\pm0.05$	$41.23^{b}\pm0.04$	$11.47^{b}\pm0.25$
80:20	$29.15^{a}\pm0.07$	$7.07^{e}\pm0.02$	$5.15^{b}\pm0.07$	$3.95^{b}\pm0.01$	$38.49^{c}\pm0.07$	$16.19^{c}\pm0.25$
70:30	$23.95^{d}\pm0.07$	$16.42^{c}\pm0.03$	$1.99^{c}\pm0.02$	$4.17^{a}\pm0.04$	$37.12^{d}\pm0.02$	$16.35^{a}\pm0.18$
60:40	$27.45^{b}\pm0.07$	$19.12^{b}\pm0.02$	$2.00^{c}\pm0.01$	$4.20^{a}\pm0.01$	$36.75^{e}\pm0.07$	$10.48^{c}\pm0.20$
50:50	$27.25^{b}\pm0.07$	$19.00^{b}\pm0.02$	$1.98^{c}\pm0.01$	$4.23^{a}\pm0.01$	$34.75^{e}\pm0.07$	$12.79^{c}\pm0.20$

The data values are mean ± standard deviation of the proximate composition. Means within a column not followed by the same superscript are significantly different ($P \leq 0.05$) from each other using Duncan multiple range test.

Key: 100%= 100% defatted sesame seed flour blend,

90:10= 90% defatted sesame flour and 10% plantain flour blend,

80:20= 80% defatted sesame flour and 20% plantain flour blend,

70:30= 70% defatted sesame flour and 30% plantain flour blend,

60:40= 60% defatted sesame flour and 40% plantain flour blend and

50:50= 50% defatted sesame flour and 50% plantain flour blend.

The ash content shows a range from 3.63% to 4.23% respectively. The samples ratio decreases: 4.23% (50:50), 4.20% (60:40), 4.17% (70:30), 3.95% (80:20), 3.89% (90:10) and 3.63% (100%). 4.23% (50:50) has the highest ash content although the ash content in accordance to (Agu, 2014). The result shows there is a good mineral composition by the addition of unripe plantain flour (Agu, 2014), by the addition of more unripe plantain flour the ash content will increase. The ash content shows a significant difference ($P \leq 0.05$) for the various samples.

The fat content of the various biscuit samples ranges from 34.75% to 44.51% respectively. The samples ratio decreases: 44.51% (100%), 41.23% (90:10), 38.49% (80:20), 37.12% (70:30), 36.75% (60:40) and 34.75% (50:50). 44.51% (100%) has the highest fat content, which may be due to the fat content used in the production, and that sesame seed contains high oil and fat content as reported by Agu, (2014). Reduction and increase in fat content down the column may be because fat crystals during stabilization of air bubbles that interface during the mixing process, which aid to soften dough according to (Rao, 2017). Fat is responsible for adding to the flavour of the final product in accordance to (Rao, 2017). The result shows a significant difference ($P \leq 0.05$) for the various samples.

The carbohydrate content ranges from 2.47% to 16.35% respectively. The samples ratio decreases: 16.35% (70:30), 16.19% (80:20), 12.79% (50:50), 11.47% (90:10), 10.48% (60:40) and 2.47% (100%). 16.35% (70:30) has the highest carbohydrate content, which may be due to the carbohydrate content in unripe plantain flour and the variation in carbohydrate down the column may be because of starch gelatinization during which the starch granular structure is deformed by the process of baking according to (Rao, 2017). Carbohydrate serves as a good source of energy (Agu, 2014). The result shows a significant difference ($P \leq 0.05$) for the various samples.

3.2 ANTIOXIDANT PROPERTY

The result of the antioxidant property of biscuit produced from defatted sesame seed and unripe plantain flour blend as shown in Table 4.

The antioxidant property in the biscuit ranges from 31.34% to 79.69%. The samples ratio follows: 79.69% (50:50), 79.49% (60:40), 70.71% (70:30), 55.65% (80:20), 35.40% (90:10) and 31.34% (100%). 79.69% (50:50) shows to contain the highest amount of DDPH (2,2-diphenyl-1picrylhydrazyl) and it increases down the column as unripe plantain proportion increases down the samples. Sample (90:10) 35.40% contains the least content of DDPH, has defatted sesame seed do not have high DDPH content in accordance to (Ahemen *et al*., 2018) and 79.69% (50:50) having the highest DDPH content because of the unripe plantain flour; the DDPH increases as unripe plantain flour ratio increases in agreement with (Shodehinde, 2012). Unripe Plantain according to (Shodehinde, 2012) to have similar DDPH content with sample 35.40 (90:10) and 55.65 (80:20). They also reduce the tendency of oxidative deterioration among food product in

TABLE 4. ANTIOXIDANT PROPERTY

Sample Code (%)	DPPH **(%)**
100	31.34^{e}±0.05
90:10	35.40^{d}±0.02
80:20	55.65^{c}±0.07
70:30	70.71^{b}±0.14
60:40	79.49^{a}±0.13
50:50	79.69^{a}±0.13

The data values are mean ± standard deviation of antioxidant property of the biscuit. Means within a column not followed by the same superscript are significantly different (P ≤ 0.05) from each other using Duncan multiple range test.

Key: 100%= 100% defatted sesame seed flour blend,

90:10= 90% defatted sesame flour and 10% plantain flour blend,

80:20= 80% defatted sesame flour and 20% plantain flour blend,

70:30= 70% defatted sesame flour and 30% plantain flour blend,

60:40= 60% defatted sesame flour and 40% plantain flour blend and

50:50= 50% defatted sesame flour and 50% plantain flour blend.

accordance to (Wilson *et al*., 2017). They are generally (antioxidant) referred to as free scavenger's radicals that prevent or reduce damages cause by oxidation; in diet high in antioxidant, they may likely reduce many diseases such as cardiovascular condition and neurodegenerative conditions in accordance to (Wilson *et al*., 2017).

3.3 MINERAL COMPOSITION

The result of the mineral composition of biscuit produced from defatted sesame seed and unripe plantain flour blend as shown in Table 5 below.

The Calcium (Ca) content in the biscuit samples ranges from 1.93 to 2.23 mg/kg. The samples ratio follows: 2.23mg/kg (90:10), 2.07mg/kg (50:50), 2.05mg/kg (60:40), 2.04mg/kg (70:30), 1.97mg/kg (80:20) and 1.93mg/kg (100%). 2.23mg/kg (90:10) has the highest calcium content, defatted sesame seed flour have been reported to contain significant content of calcium unlike unripe plantain, which calcium content is slightly negligible in comparison to defatted sesame seed, Calcium is responsible for strong bone and teeth in the body according to (Agu, 2014). Although result show different variation with the blend ratios. The result shows significant difference ($P \leq 0.05$) for the various samples.

The Iron (Fe) content in the biscuit samples ranges from 0.78 to 3.78mg/kg. The samples ratio follows: 3.78mg/kg (100%), and 3.15mg/kg (80:20), 3.05mg/kg (50:50), 2.99mg/kg (60:40), 2.58mg/kg (70:30) and 1.97mg/kg (80:20). 3.78 mg/kg (80:20) appear to have the highest quantity of iron present in it. Both defatted sesame flour and unripe plantain contain significant quantity of iron according to (Agu, 2014). Iron is essential in the blood stream to carry oxygen from the lungs to other part of the body and helps in the formation of hemoglobin according to (Agu, 2014). Although result show different variation with the blend ratios. The result shows significant difference ($P \leq 0.05$) for the various samples.

TABLE 5. MINERAL COMPOSITIONS (mg/kg)

Sample Code (%)	Calcium (Ca)	Iron (Fe)
100	$1.93^{e}\pm0.01$	$3.78^{a}\pm0.04$
90:10	$2.23^{d}\pm0.04$	$0.78^{d}\pm0.04$
80:20	$1.97^{c}\pm0.03$	$3.15^{b}\pm0.07$
70:30	$2.04^{b}\pm0.02$	$2.58^{c}\pm0.04$
60:40	$2.05^{a}\pm0.02$	$2.99^{c}\pm0.01$
50:50	$2.07^{a}\pm0.01$	$3.05^{a}\pm0.07$

The data values are mean ± standard deviation of mineral composition of the biscuit. Means within a column not followed by the same superscript are significantly different ($P \leq 0.05$) from each other using Duncan multiple range test.

Key: 100% = 100% defatted sesame seed flour blend,

90:10 = 90% defatted sesame flour and 10% plantain flour blend,

80:20 = 80% defatted sesame flour and 20% plantain flour blend,

70:30= 70% defatted sesame flour and 30% plantain flour blend,

60:40= 60% defatted sesame flour and 40% plantain flour blend and

50:50= 50% defatted sesame flour and 50% plantain flour blend.

3.4 PHYSICAL QUALITY

The result of the physical quality of biscuit produced from defatted sesame and unripe plantain flour blend as shown in table 6.

The biscuit thickness ranges from 0.96cm to 1.24cm respectively. The samples ratio follows: 1.24cm (100%), 1.19cm (80:20), 1.08cm (90:10), 0.98cm (60:40), 0.97cm (50:50) and 0.96cm (70:30). 1.24cm (100%) being the highest thickness which may be as result of the quantity of sugar used during creaming, sugar causes the dough to be stiff according to (Rao, 2017). The result showing different degree of variation among the different biscuit samples at a significant difference of ($P \leq 0.05$).

The diameter ranges from 4.85 to 5.06cm respectively. The samples ratio follows: 5.06cm (80:20), 4.99cm (100%), 4.94cm (70:30), 4.87cm (50:50), 4.86cm (50:50), 4.86cm (70:30) and 4.85cm (50:50). 5.06cm (80:20) having the highest diameter, which may be due to the incorporation of the flour blend with sesame flour blend have a dispersed property during and after baking (Agu, 2014). The usage of sugar has been reported to increase the diameter or length of biscuit product (Rao, 2017). Showing that sugar rich biscuit usually have lower numeric value for thickness and higher numeric value for diameter or length in accordance to (Gernah, 2014). The result showing different degree of variation among the different biscuit samples are not significantly different for ($P \leq 0.05$).

The weight of biscuit ranges from 6.93g to 7.57g respectively. The samples ratio follows: 7.57g (100%), 7.24g (90:10), 7.19g (60:40), 7.13g (80:20) and 6.92 (50:50). 7.57g (100%) being the highest weight. The increase in the use of flour proportion, which contains resistant starch shows that it increases in the proportion usage causes stiffness of dough thereby affecting the increase of the final weight of the biscuit, also implying that decrease in protein decreases the weight as resistant starch increases according to (Rao, 2017) and (Agu, 2014). Weight can be attributed to Co_2 during the process of leavening thereby causing an increase in the weight and low-density yeast-raised product according to (Rao, 2017). Sugar content during mixing as also was attributed weight loss during mixing by many food engineers according to (Rao, 2017). The result showing different degree of variation among the different biscuit samples at a significant difference of ($P \leq 0.05$).

The break strength of the biscuit ranges from 770.00 to 875.00g respectively. The samples ratio follows: 875.08g (90:10), 875.08g (60:40), 875.08g (50:50), 775.00g (100%), 775.00g (80:20) and 770.00g (70:30). 875.08g (90:10, 60:40 and 50:50) is the highest break strength, the break strength is the weight requirement to fracture the biscuit into halves, it is an important parameter in packaging according to (Agu, 2014). According to Agu, (2014) that fiber content of unripe plantain increases the bulk structure of biscuit giving it a cohesive structure leading to a high break strength. The result shows a significant difference of ($P \leq 0.05$).

TABLE 6. PHYSICAL PROPERTIES

Sample Code (%)	Thickness (cm)	Diameter (cm)	Weight (g)	Break strength (g)	Spread Ratio (cm)
100	$1.24^{a}\pm0.04$	$4.99^{a}\pm0.12$	$7.57^{a}\pm0.01$	$775.00^{b}\pm35.36$	$5.34^{a}\pm0.08$
90:10	$1.08^{a}\pm0.03$	$4.85^{a}\pm0.11$	$7.24^{b}\pm0.04$	$875.00^{a}\pm35.36$	$4.48^{b}\pm0.02$
80:20	$1.19^{a}\pm0.11$	$5.06^{a}\pm0.07$	$7.13^{c}\pm0.04$	$775.00^{b}\pm35.36$	$4.56^{b}\pm0.06$
70:30	$0.96^{b}\pm0.07$	$4.86^{a}\pm0.07$	$7.19^{bc}\pm0.01$	$770.00^{b}\pm28.28$	$5.08^{ab}\pm0.45$
60:40	$0.98^{b}\pm0.07$	$4.87^{a}\pm0.07$	$6.93^{d}\pm0.07$	$875.00^{a}\pm35.36$	$5.45^{b}\pm0.37$
50:50	$0.97^{b}\pm0.07$	$4.86^{a}\pm0.07$	$6.93^{e}\pm0.07$	$875.00^{a}\pm35.36$	$5.43^{b}\pm0.37$

The data values are mean ± standard deviation of physical property of the biscuit. Means within a column not followed by the same superscript are significantly different ($P \leq 0.05$) rom each other using Duncan multiple range test. .

Key: 100%= 100% defatted sesame seed flour blend,

90:10= 90% defatted sesame flour and 10% plantain flour blend,

80:20= 80% defatted sesame flour and 20% plantain flour blend,

70:30= 70% defatted sesame flour and 30% plantain flour blend,

60:40= 60% defatted sesame flour and 40% plantain flour blend and

50:50= 50% defatted sesame flour and 50% plantain flour blend.

The spread ratio of the biscuit ranges from 4.56 to 5.43cm respectively. The samples ratio follows: 5.45cm (50:50), 5.43cm (60:40), 5.34cm (100%), 5.08cm (70:30), 4.56cm (80:20) and 4.48cm (90:10). 5.45cm (50:50) have the highest spread ratio value. Spread ratio informs about the ability for biscuit to rise and the quality, which may be because of increase or decrease in protein during blending according to (Agu, 2014). Leavening that affect spread ratio as result the biochemical and physiochemical reaction that affect Co_2 from yeast fermentation when the gas is trapped in the food structure and held until it expands during the biscuit formation (Rao, 2017). Unripe plantain and sesame seed according to Agu (2014) to have poor structure formation in their molten form after baking. The cohesiveness of the break strength have been reported to be having by protein network for cookies according to (Rao, 2017). The result showing different degree of variation among the different biscuit samples at a significant difference of ($P \leq 0.05$).

3.5 SENSORY ACCEPTABILITY

The result of the sensory property of biscuit produced from defatted sesame seed and unripe plantain flour blend as shown in Table 7.

The taste means score range from 5.55 to 8.00 respectively. The samples ratio follows: 8.00 (80:20), 7.80 (90:10), 6.60 (60:40), 6.25 (70:30), 6.00 (60:40) and 5.55 (50:50). 8.00 (80:20) appear to be the most preferred biscuit sample based on taste preference by the panelist. This may be because the sample with less unripe plantain shows to be more acceptable from Table 7, fat and sugar have been said to improve the taste of biscuit according to (Rao, 2017). The result shows a significant difference ($P \leq 0.05$) for the various samples.

The aroma means score ranges from 5.45 to 7.35 respectively. The samples ratio follows: 7.35 (80:20), 7.05 (90:10), 6.40 (100%), 6.05% (70:30), 5.65 (60:40) and 5.45 (50:50). 7.35 (80:20) appear to be the most preferred biscuit sample based on aroma preference by the panelist. Mailard reaction and the degree of baking temperature have been reported to affect aroma acceptability of baked product according to (Rao, 2017). The result shows a significant difference ($P \leq 0.05$) for the various samples.

The colour means score ranges from 5.55 to 7.30 respectively. The samples ratio follows: 7.30 (100%), 7.25 (80:20), 7.10 (90:10), 6.00% (70:30), 5.75 (60:40) and 5.55 (50:50). 7.30 (100%) appear to be the most preferred biscuit sample based on colour appeal. Colour change might because of Maillard reactions, which occur during gelatinization of starch sugar and protein denaturing according to (Rao, 2017). Previous works relating to unripe plantain and sesame seed shows that sesame seed is the predominant influence of the colour of the final product, which is the case for flours with the highest ratio during blending according to (Agu, 2014). Although result show different variation as blend ratios increases without a specific pattern. The result shows significant difference ($P \leq 0.05$) for the various samples.

TABLE 7. SENSORY PROPERTIES

Sample Code	Taste	Aroma	Colour	Mouth feel	Overall Acceptability
100	$6.60^{a}\pm2.06$	$6.40^{a}\pm1.70$	$7.30^{a}\pm1.13$	$6.85^{a}\pm1.63$	$7.00^{ab}\pm1.62$
90:10	$7.80^{b}\pm1.15$	$7.05^{b}\pm1.19$	$7.10^{a}\pm1.46$	$6.80^{a}\pm1.54$	$7.30^{ab}\pm1.34$
80:20	$8.00^{b}\pm1.21$	$7.35^{b}\pm1.23$	$7.25^{a}\pm1.25$	$7.10^{a}\pm1.25$	$7.85^{ab}\pm1.39$
70:30	$6.25^{a}\pm1.71$	$6.05^{a}\pm1.67$	$6.00^{b}\pm1.59$	$6.40^{a}\pm2.01$	$6.55^{a}\pm1.85$
60:40	$6.00^{a}\pm1.99$	$5.65^{a}\pm1.67$	$5.75^{b}\pm2.06$	$6.10^{a}\pm1.45$	$6.45^{a}\pm1.89$
50:50	$5.55^{a}\pm1.99$	$5.45^{a}\pm1.67$	$5.55^{b}\pm2.06$	$6.00^{a}\pm1.45$	$6.25^{a}\pm1.89$

The data values are mean ± standard deviation of 20 panelists. Means within a column not followed by the same superscript are significantly different ($P\leq 0.05$).

Key: 100%= 100% defatted sesame seed flour blend,

90:10= 90% defatted sesame flour and 10% plantain flour blend,

80:20= 80% defatted sesame flour and 20% plantain flour blend,

70:30= 70% defatted sesame flour and 30% plantain flour blend,

60:40= 60% defatted sesame flour and 40% plantain flour blend and

50:50= 50% defatted sesame flour and 50% plantain flour blend.

The mouth feels mean score of the biscuit ranges from 6.00 to 7.10 respectively. The samples ratio follows: 7.10 (80:20), 6.85 (100%), 6.80 (90:10), 6.40 (70:30), 6.10 (60:40) and 6.00 (50:50). 7.10 (80:20) appear to be the most preferred biscuit based on crunchiness of the biscuit during chewing or injection. Mouth feel has been as reported to be influenced by baking temperature and melting of fat and heating of sugar. The coagulation of protein and partial gelatinization, which is partly responsible for the structure of the biscuit after baking according to (Rao, 2017).

The mean score overall acceptability of the biscuit ranges from 6.25 to 7.85 respectively. The samples ratio follows: 7.85 (80:20), 7.30 (90:10), 7.00 (100%), 6.55 (70:30), 6.45 (60:40) and 6.25 (50:50). The 7.85 (80:20) was the most preferred sample based on all parameters such as taste, colour, aroma and mouth feel because the panelist generally preferred this blend. The appropriate condition and proper preparation method or procedure for baking are usually the condition for baking and affect the final product quality according to (Rao, 2017). This measuring sensory index generally informs the producers which product are marketable viable to be produce according to (Rao, 2017).

4.0 CONCLUSION

The result of the biscuit produced from the blend of defatted sesame seed flour and unripe plantain flour show significant changes for the proximate composition (high crude protein content, fat and crude fiber content (80:20) and a reasonable of amount ash and moisture), the antioxidant composition (DDPH scavenging radical) increases as the proportion of unripe plantain flour increases. The mineral composition (especially rich in iron than calcium) is rich in iron, which is needed in the body formation for hemoglobin in the red blood cell, the physical quality of the biscuit was acceptable and the sensory mean score was more acceptable for sample 80:20 in terms of taste, colour, aroma, mouth and the overall acceptability of the biscuit.

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