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QUALITY CHARACTERISTICS OF BISCUITS PRODUCED FROM WHEAT, TIGERNUTS AND DEFATTED SESAME SEEDS BLENDED FLOUR

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ABSTRACT

The study was conducted to evaluate the quality attributes of biscuits produced from wheat flour, sesame seeds and tigernut blended flours. Three Biscuits samples were made with varying proportion of 100%, 70% and 60% wheat flour replaced with 0%, 20%, 15% and 0%, 15%, 25% tiger nut and defatted sesame seeds flours respectively. The products were analyzed for colour, texture, aroma, taste and over-all acceptability by untrained panelists using 9-point hedonic Scale. Biscuits samples were baked and analysed for nutritional compositions and sensory evaluation. The samples had moisture 21.37 % - 426.82%, Ash, 0.95%-1.50%, protein, 10.09% - 15.31%, fat, and 26.26%- 30.43% and carbohydrate, 36.78%- 39.50%. Incorporation of tigernut and sesame seed flours increased the moisture, ash, protein, and fat contents while increasing the composite flours reduced the Carbohydrate content in the biscuits. Sensory assessment revealed a significant (p<0.05) difference between the control sample (100% wheat flour) and the composites in terms of colour, flavour, taste, texture and overall acceptability of the biscuits. The biscuit sample B (70% wheat flour, 20% Tigernuts flour and 10% sesame flour) was highly accepted by the panelists

KEY WORDS: ***Biscuits, tigernut flour, wheat flour, sesame seeds, nutritional composition***

INTRODUCTION

Biscuits are one of the most popular bakery products made from cereal that are consumed by nearly all people in the world. They are snacks produced from unsweetened dough that is changed into an interesting product by baking [1]. They are made from wheat flour, sugar, milk, fat, flavouring agents and other raising agents [2], [3]. Biscuits are ready-to-eat, convenient and inexpensive food product, containing digestive and dietary fibres which are vital to the body [4]. Biscuits are rich source of fat and carbohydrate, hence are energy giving food and they are also a good source of protein and minerals [1]. 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 [5].

Wheat flour is a staple ingredient in the production of biscuits due to its protein content, which is not found in other grain flour. Wheat flour is obtained from the grinding of wheat and it is used in the preparation of pastries, batters and dough. Some essential amino acids such as lysine, tryptophan and threonine are missing in wheat flour [6]. Consequently, the low nutritional value of biscuits is of great concern as biscuits are the most consumed snacks by school children who need more protein per unit body weight than adults [7]. This has led to the development and use of compound flours in the production of biscuits, breads and confectioneries. Wheat is mainly used as the grain of choice for production of this snack product, however, due to climatic conditions; it is not grown in tropical regions of Ghana. Thus, for the production of baked goods in areas where the supply of wheat is limited. As demand increases, there is a tendency for wheat flour prices to increase, as well as an increase in the cost of importing it into the country [8]. This high cost is due to the fact that population growth has increased the consumption of baked goods thereby increasing the demand for imported products. It is estimated that, in the year 2017 and 2018, Ghana imported 700,000 tons of wheat flour into the country which is about 5.4% increase in 2016-2017[9].

Tigernut (*Cyperus esculentus*) is underutilized crop, which has high dietary fibre content and it is very effective in the treatment and prevention of many diseases including colon cancer, coronary hearth diseases, obesity, diabetics and gastro intestinal disorders [10]. Tigernut flour has been demonstrated to be a rich source of quality oil and contains moderate amount of protein, carbohydrate, sugars, phosphorus and potassium [11]. It is also an excellent source of some useful minerals such as iron and calcium which are essential for body growth and development [12]. It is often eaten raw, baked as a vegetable, roasted or dried and ground into flour. The ground flour is mixed with sorghum to make porridge, ice-cream, sherbet or milky drink [11].

Sesame (*Sesamum indicum L., Pedaliaceae*) is one of the oldest and essential oilseed crop known to mankind. It is widely used in baking and confectionary products. They are the affluent source of fat, protein, carbohydrates, dietary fiber, zinc, magnesium, and many other minerals [13]. Sesame seeds are an excellent source of copper, a very good source of manganese, and a good source of magnesium, copper, vitamin E, thiamine, calcium, phosphorus, iron, zinc, molybdenum, phytosterols and selenium[14]; [15].

The increasing importance of snack foods such as biscuits in today's eating habits has not been fully exploited in the developing countries. This probably is as a result of the prohibitive cost of imported wheat which leads to high cost of baked products [16]. Also wheat has given issues in recent years about gluten related allergies [17] and therefore not suitable for those who have weight problem, celiac disease or diabetes. Biscuits are produced from the flour of wheat which is a cereal. Cookies studies had looked into the non-wheat flours in other to reduce cost of bakery products [16]. However, in many countries, *Cyperus esculentus* is considered as weed [18]. Tiger-nut is not widely used in agriculture and therefore has been poorly investigated [19].

Therefore, it is believed that the production of biscuits with wheat flour, tigernut and sesame seed will increase the nutritional value of biscuits especially in protein, fat and fiber contents. The objective of the study was to assess quality characteristics of wheat, tigernuts and defatted sesame flour blended biscuits.

MATERIALS AND METHODS

Sesame seed (*Sesamum indicum*) was bought from Navrongo market while wheat flour, sugar, margarine, baking powder, salt and vanilla essence were purchased from Kumasi central market, Ashanti region, Ghana.

Processing of full fat and defatted sesame seed flours

Two hundred grams (200g) of dehulled seeds were procured from Navrongo market. The seeds were sorted, washed and dried in the sun. The dried seeds were blended and oil expeller was used to reduce the quantity of oil; after which the flour was dried at 60°C for 12 hours and finely powdered using mechanical blender.

Preparation of tigernut flour

The approach of [20] was used in the preparation of tigernut flour. Dried tigernuts were taken care of to dispose of undesirable substances like stones, pebbles and other unwanted substances, before washing with tap water. The prepared nuts were dried in an oven at 60oC for 24 hours to a moisture content of 10%. The dried nuts were milled and sifted through 600 µm conical sieve until a fine flour texture was achieved. The subsequent flour was filled in transparent polythene and sealed for further analysis. The experiment was also conducted at the Mycotoxin and Food Analysis laboratories, Department of Food Science and Technology, College of Science, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

Preparation of the various flours blends

Flour blends comprising varying proportions of Wheat, Tigernut and Sesame flour 100:0:0, 70:20:10 and 60:25:15 were prepared by mixing required amounts of respective flours.

The composite flour was formulated in different ratios with wheat being the highest. The three mixture components in this study were 100% wheat flour (A), B (70% wheat flour, 20% Tigernuts flour and 10% sesame flour) and C (60% wheat flour, 25% sesame flour and 15% Tigernuts flour). Table 1 shows the composite flour and their ratios.

Table 1: Formulation of ingredients for Biscuit making

INGREDIENTS	A	B	C
Soft wheat flour (g)	100	70	40
Tigernuts flour	0		
Sesame seeds flour	0		
sugar (g)	60	60	60
Margarine (g)	50	50	50
Baking powder (g)	10	10	10
Salt (g)	1	1	1
Vanilla essence (ml)	5	5	5

Sample A (100% wheat flour), B (70% wheat flour, 20% Tigernuts flour and 10% sesame flour) and C (60% wheat flour, 25% sesame flour and 15% Tigernuts flour).

Biscuit Preparation

Author [21] creaming method was modified and used to make the biscuit dough. Biscuits were prepared with a few changes to the recipes using flour 100g, sugar 60g, baking powder 10g and salt 5g and margarine 50g. The dry ingredients except sugar were combined in a mixing bowl by hand for about 3 minutes for uniformity. In another bowl, margarine together with sugar was creamed until fluffy and dry ingredients incorporated and the dough was lightly kneaded. The dough was rolled with a rolling pin and was cut in a round shape with a round biscuit cutter. The biscuits were arranged in a greased baking sheet, allowed to rest for 10 minutes and baked in an industrial oven at 180°C for 25 minutes before being cooled to room temperature, packaged in zip lock packets, and stored in airtight containers at 37°C for further analysis. The biscuit prepared with s100% wheat flour was treated as control [22].

Proximate composition

The biscuit samples were assessed to determine their nutritional quality. The parameters determined according to standard methods [23] were moisture, ash, protein, fat and carbohydrate contents.

Moisture content and total solids: Oven Drying Method

Five grams (5g) of the sample was transferred to the previously dried and weighed dish. The Dish was placed in an oven and thermostatically controlled at 105 degrees for 5 hours. Dish was removed and placed in a desiccator to cool to room temperature and weighed. It was then dried again for 30 minutes, cooled down again and weighed. Drying, cooling and weighing were repeated until a constant weight was reached. (Alternatively, sample could be dried in a thermostatically controlled oven for at least 8 hours where a constant weight would be achieved). The determinations were duplicated and the average found [24].

Calculations

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

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

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

Where wt= Weight of sample/spread

Ash content

5g sample was weighed into a tarred crucible and was pre-dried. Crucibles were placed in cool muffle furnace using tongs, gloves and protective eyewear. The crucibles Ignited for 2 hours at about 600 degrees Celsius. Muffle furnace was turned off and opened when temperature dropped to at least 250 degrees preferably lower. The door was carefully opened to avoid losing ash that may be fluffy. Safety tongs was used to transfer crucibles to a

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desiccator with a porcelain plate and desiccant. Desiccator was closed and allowed crucibles to cool prior to weighing

Calculations

$$\%Ash = \frac{\text{wt of ash}}{\text{Wt of sample}} \times 100$$

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

Where wt= Weight of sample/spread

Fat content: soxhlet extraction

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

$$\%\ Fat\ (dry\ basis) = \frac{\text{fat/oil collected} \times 100}{\text{Weight of sample}}$$

$$\%\ Fat\ (dry\ basis) = \frac{(\text{wt of flask + oil}) - \text{wt. of flask} \times 100}{\text{Weight of sample}}$$

Crude fibre determination

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

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

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

Where wt= Weight of sample/spread

Protein Determination

Digestion Method

Two grams (2g) of sample and a half of selenium –based catalyst tablets and a few anti-bumping agents were added to the digestion flask. Twenty five milliliters (25ml) of concentrated H_2SO_4 was added and the flask was shaken for the entire sample to become thoroughly wet. Flask was placed on digestion burner and heated slowly until boiling ceased and the resulting solution was clear. The sample was then cooled to room temperature and digested sample solution was transferred into a 100ml volumetric flask and made up to the mark.

Distillation Method

To flush out the apparatus before use, distilled water was boiled in a steam generator of the distillation apparatus with the connections arranged to circulate through the condenser, for at least 10 minutes. The receiving flask was lowered and continued to heat for 30 seconds in order to carry over all liquid in the condenser. 25 ml of 2% boric acid was pipetted into 250ml conical flask and 2 drops of mixed indicator added. The conical flask and its contents were placed under the condenser in such a position that the tip of the condenser is completely immersed in solution. 10ml of the digested sample solution was measured into the decomposition flask of the Kejdahl unit, fixed it and add excess of 40% NaOH (about 15-20ml) to it. The ammonia produced was distilled into the collection flask with the condenser tip immersed in the receiving flask till a volume of about 150ml– 200ml is collected. Before distilling another sample and on completion of all distillations, the apparatus was flushed as in step 1 above. Steam was allowed to pass only until 5ml of the distillate is obtained.

Titration Method

The Distillate with 0.1N HCL solution was titrated. The acid was added until the solution became colourless. Any additional acid added made the two solutions become pink. The nitrogen content was determined in duplicate, and a blank determination was run using the same amount of all reagents as used for the sample. The blank was meant to correct for traces of nitrogen in the reagents and included digestion as well as distillation methods.

Calculation:

$$\% \text{ Total nitrogen} = \frac{100 \times (Va - Vb) \times NA \times 0.01401 \times 100}{W \times 10}$$

Where:

Va- volume in ml of standard acid used in titration

Vb- volume in ml of standard acid used in blank

NA- normality of acid

W- Weight of sample taken

Carbohydrate content

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

Calculation:

Carbohydrate (%) = % crude fibre + % NFE

OR

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

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

Sensory evaluation

Fifty (50) untrained panelists were randomly selected from the Hospitality Management Department, Bolgatanga Technical University for the sensory evaluation on the biscuits samples. These samples were evaluated for colour, texture aroma, taste and over-all acceptability. Panelists' were provided with water to rinse their mouths in between each sample evaluation. A nine point hedonic scale as described by Ihekoronye and Ngoddy [25] was used for rating with 9 = like extremely, 5 = neither like nor dislike, and 1 = dislike extremely.

Statistical analysis

All analyses were conducted in duplicates and the data obtained were analyzed Data were analyzed using the software, Statistical Package for Social Sciences (SPSS) version 22.00 (SPSS inc., Chicago), IL, USA at the 0.05 level of significance. Data were subjected to analysis of variance (ANOVA) and Turkey's test was utilized for comparison of means. Significance was accepted at p =<0.05.

RESULTS AND DISCUSSION

Table 2 shows the nutrient composition of biscuit samples fortified with different levels of tigernut flour (15%, 20% and defatted sesame flour (10% and 25%). The moisture content ranged from 21.37-26.82% with biscuit sample C (60% wheat flour, 25% sesame flour and 15% Tigernuts flour) having the highest percentage score (26.82%) and the least score was the control sample (100% wheat flour). The moisture content decreased from 21.37% for the control. Increasing sesame seed and tigernut flour increased the water content of biscuit samples. Biscuit sample with high moisture content may have a shorter shelf life, as high moisture content is associated with a short shelf life of baked goods as they promote microbial growth, which leads to spoilage [26]; [27]. On the other hand, the low moisture content could decrease the development of microorganisms thus prolonging the shelf life of the product. Low moisture content in baked goods is essential for extending the shelf life [28]. The results showed a significant differences (P<0.005) between all biscuit samples.

The ash content of biscuit ranges from 0.95% - 1.50%. Biscuit sample produced from 70% wheat flour, 20% tigernut flour and 10% sesame flour have high ash content (1.50%), while biscuits with 100% wheat flour recorded low (0.95%) ash content, indicating that tigernut and sesame flour blends have sufficient Mineral elements. Addition of tiger nut and sesame flour increases the ash content in the biscuits. Usually the ash content of composite biscuits increases as the level of fortification increases, this means that, biscuits fortified with other indigenous raw materials would have more nutritional values than 100% wheat flour. Author [29] reported that ash content of any food item signifies the inorganic elements acquired after the burning of organic matter in the food, and these inorganic materials form strict structures and regulators of mineral elements which are beneficial to the Body. Author [30] also asserted that the presence of ash is an indication of minerals present in the sample. The ash content of the samples B (70% wheat flour, 20% Tigernuts flour and 10% sesame flour) and C (60% wheat flour, 15% Tigernuts flour and 25% sesame flour) increased as substitution of wheat flour decreased.

Partial Replacement of tigernut and defatted sesame seed flours for wheat flour in the sample biscuits increased the protein. Biscuit made of 70% wheat flour, 20% Tigernuts flour and 10% sesame flour had the highest protein (15.31%) followed by sample C (60% wheat flour, 25% sesame flour and 15% Tigernuts flour) and the least was the control (100% wheat flour). It was observed that protein content increased (p<0.05) with increasing levels of 20% and 10% tigernut and sesame flours substitution. There was significant difference in the protein content of the sample produced from 100% wheat flour and the composite samples. This may be due to the fact that the tigernut and sesame flours contain protein [31].

Biscuit sample C made of 60% wheat flour, 25% sesame flour and 15% Tigernuts flour recorded highest fat content (12.43%) and lowest in was sample A (100% flour) (4.26%). This indicates that tiger nut and sesame flours contain enough oil and therefore increased the content of fat in the biscuit. Author [32] and [25] indicated that high fat content of tiger nut and sesame flours improve its nutritional density and increases its value as a substitute dietary supplement in the nourishments of livestock and mankind. This finding is in line with the discovery Omar and [33] and [34] who prepared cookies from wheat-defatted cashew nut and wheat-brewers spent grain flour blends and recorded high fat content (2.52–4.80%). The high fat content of biscuit means that they generate a lot of heat and also act as a lubricant to improve the quality of the product in relations of taste and texture. Adding, fat is a vital source of energy as it leads to the development of bad flavours in the diet [25]. Fat is very significant in the diet as it helps absorb vitamins, replenishes fat cells and insulates the body to keep it warm.

The carbohydrate contents ranged from 37.56-39.56% in all the sample biscuits produced. 100% wheat bread recorded the highest carbohydrate content (39.56%) followed by sample C (60% wheat flour, 25% sesame flour and 15% Tigernuts flour). It was perceived that carbohydrate content in the 100% wheat flour biscuit increased (p<0.05) but increasing the levels of tigernut and sesame flours decreased the carbohydrate content. There were significance differences (p<0.05) in carbohydrate between all the biscuit samples. Carbohydrates, which are plentiful in wheat flour, have been reduced with less carbohydrate fat free flour and whole sesame seed flour. This is a good method to improve the nutritional excellence of biscuit made from such composites compared to 100% wheat flour [35].

Table 2 Proximate composition biscuit samples

Sample	**Moisture**(g/100g)	**Ash**(g/100g)	**Protein**(g/100g)	**Fat**(g/100 g)	**CHO**(g/100 g)
A	21.37± 0.98	0.95± 0.03	10.09± 0.79	26.26± 0.06	39.50± 0.93
B	25.49± 0.75	1.50± 0.01	15.31± 0.35	27.79± 0.08	37.56± 0.61
C	26.82± 0.17	1.27± 0.03	14.05± 0.075	30.43± 1.08	36.78± 0.73

Sample A (100% wheat flour), B (70% wheat flour, 20% Tigernuts flour and 10% sesame flour) and C (60% wheat flour, 25% sesame flour and 15% Tigernuts flour).

SENSORY QUALITY OF BISCUIT SAMPLES

Table 3 indicates the sensory quality of biscuit samples produced with different levels 20%, 10% and 25%, 15% of tigernut and defatted sesame seed flour blends. Panelists rated the colour of biscuit sample B (70% wheat flour, 20% tigernuts flour and 10% sesame flour) high (9.50%) and biscuit sample with 100% wheat flour (8.01%) lower. The results revealed the significant difference ($p<0.05$) between the control biscuit sample (100% wheat flour) and all fortified samples B (70% wheat flour, 20% tigernuts flour and 10% sesame flour) and C (60% wheat flour, 25% sesame flour and 15% tigernuts flour) in colour, taste, flavour, texture and overall acceptability. Nevertheless, Sample A (100% wheat flour) and B (70% wheat flour, 20% tigernuts flour and 10% sesame flour) were highly accepted in virtually all the sensory characteristics appraised. This result proposes the possible use of tigernut and sesame seed blended flour in baking industry.

Table 3 Sensory attributes of biscuits

Sample	Colour	Taste	Flavour	Texture	Overall Acceptability
A	8.01 ± 0.76	8.79 ± 1.13	7.95 ± 1.17	8.79 ± 0.98	8.83 ± 0.73
B	8.50 ± 0.83	9.08 ± 0.97	9.5 ± 1.75	8.80 ± 1.01	9.10 ± 0.80
C	7.61 ± 0.72	8.15 ± 0.72	9.6 ± 1.85	7.86 ± 1.18	8.58 ± 0.67

Sample A (100% wheat flour), B (70% wheat flour, 20% Tigernuts flour and 10% sesame flour) and C (60% wheat flour, 25% sesame flour and 15% Tigernuts flour).

CONCLUSION

Addition of defatted sesame seed and tigernut flours in wheat flour at 10%, 20% and 15%, 25% replacement resulted in remarkable rise in Ash, protein, fat and carbohydrate contents while moisture content reduced. The important increase in the nutritional contents could be beneficial for biscuit eaters, especially, school children. The result obtained also showed that tigernut and defatted sesame seed blended flours could be used to provide inexpensive biscuits substitutions for consumers.

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