

Production and Quality Assessment of Protein-Rich Biscuits from Blends of Wheat and Defatted Sesame Flours

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Abstract: The effect of wheat flour supplementation with sesame flour on the quality of biscuits was determined. Biscuits were produced from various blends of wheat and defatted sesame flour (90:10, 80:20 and 70:30), with 100% wheat flour serving as control. Physico-chemical and sensory properties were then determined using standard methods of analysis. Protein, fat, fiber and ash contents increased, while carbohydrate content decreased significantly ($p < 0.05$) ranging from 10.20 to 16.84 %, 2.08 to 5.23%, 1.20 to 2.66%, 1.37 to 2.03 and 76.45 to 63.53% respectively from control to the sample with 30% defatted sesame substitution. While there was no significant increase ($p > 0.05$) in weight (9.35 to 9.86g), there was significant ($p < 0.05$) increase in diameter and spread ratio of biscuits with values ranging from 4.30 to 4.83 and 30.07 to 58.19, respectively. There was a significant difference ($p < 0.05$) in thickness between the control (100% wheat) and other samples changing from 1.43 to 0.83cm. Mean sensory scores showed an increase in appearance, aroma and texture of biscuits though there was a decline at the highest level (30%) of substitution. The 10% defatted sesame sample gave the highest scores for taste and acceptability. The study shows that acceptable and nutritious biscuits could be produced from composite blends of wheat flour and defatted sesame flour.

Keywords: Acceptability, Flour blends, Physico-chemical properties, Sesame, Substitution, Blends.

INTRODUCTION

Biscuits, also known as cookies, are a snack food consumed extensively all over the world. They are ideal for nutrient availability, palatability, compactness and convenience and differ from other baked products like bread and cakes because of their low moisture content, comparative safety from microbial spoilage and long shelf life [1]. Though not indigenous to Nigeria, they have gained popularity here, especially in urban areas, where they are consumed in homes, schools and work places [2].

Traditionally, biscuits are produced from wheat flour. However, the fact that wheat cannot be economically produced in Nigeria (and the tropical countries in general) due to climatic conditions has necessitated research on the use of local flours as substitutes for wheat in the production of baked products including biscuits. Acceptable biscuits have been produced from composite blends of wheat flour and various cereal/legume flours [3-7]. It has also been reported that 100% non-wheat flour can be used to produce biscuits, which do not depend on gluten for structure such as biscuits, wafers and shortcakes [8].

Worldwide, an estimated 30 million metric tonnes (MT) of sesame seeds are produced annually. Though total production fluctuates from country to country

annually, as at 2010, Burma was the highest producing country, closely followed by India, China, Ethiopia and Sudan in that order [9]. In Nigeria, sesame is produced mainly in the Central, North Western and North Eastern Zones, where it is utilized for various purposes and also serves as a cash crop. Adeyemo *et al.* [10] reported that more than 90% of the sesame produced in Nigeria comes from Benue State in central Nigeria. In Benue State, the crop is produced in commercial quantities in Guma, Gwer, Kastina Ala, Makurdi and Vandekya local government areas.

Sesame seed, which is reported to be rich in protein (with high levels of methionine and moderate levels of lysine), vitamins, minerals and unsaturated fatty acids [11, 12] would make an excellent protein complement to other plant proteins. The typical nutty and slightly sweet flavour could complement the flat, bland taste of wheat to produce more acceptable biscuits.

The aim of this study was therefore, to assess the possibility of producing protein-rich acceptable biscuits from blends of wheat and defatted sesame flours. The attractiveness of this research is also the trend in the production of functional foods using locally available raw materials, especially waste products.

MATERIALS AND METHODS

Material Procurement

Two (2.0) kg of white sesame (NCRI var. E8) was purchased from the National Cereals Research

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Institute, Akperan Orshi College of Agriculture, Yandev (AOCAY), Gboko; while 5.0 kg of wheat flour and other baking ingredients were purchased from a supermarket in Makurdi, Banue State.

Material Preparation

The seeds were cleaned and sorted by soaking in clean tap water and removing the seeds that floated. Thereafter good seeds were dehulled by the method of Ramachandra *et al.* [13] as described by Gernah [12]. The seeds were boiled in 0.6% Sodium hydroxide (NaOH) solution for one (1) minute, after which they were washed with excess cold water by scrubbing between the palms to remove the NaOH and seed coats respectively. The ruptured seed coats were separated by air drying and then winnowing.

Preparation of Defatted Sesame Flour

The dehulled seeds were defatted using a modification of the method described by Visser and Thomas [14]. Sesame seeds were coarsely milled in an attrition mill (Asiko II, Addis, Nigeria), after which 10.0 gram batches were defatted in the Soxhlet apparatus for three (3) hours at low temperatures of 60-80°C. The defatted coarsely ground sesame seeds were then desolventized (removal of hexane through drying and evaporation), finely blended in a Phillips (HR 1702) blender and dried in an air draft oven (Genlab Widnes, model T 12 H) at 60°C to a moisture content of about 10% to obtain the defatted sesame flour.

Preparation of Biscuits

Blends with different proportions of wheat flour and defatted sesame were prepared as shown in Table 1, with 100% wheat flour serving as control. A digital electronic weighing balance (Metra, model TL 600) and a Phillips (HR 1702) blender were used for weighing and mixing the flours.

Table 1: Formulation of Blends (%) for Biscuits Production

Flour Blends	Wheat Flour (%)	Defatted Sesame Flour (%)
A	100 (Control)	-
B	90	10
C	80	20
D	70	30

Biscuits were then prepared using the method described by Olugbemi [15]. The baking ingredient composition used is shown in Table 2.

Table 2: Ingredient Used for the Preparation of Biscuits

Ingredient	Quantity (g)
Wheat/ Defatted Sesame Flour	100.00
Baking fat	45.00
Sugar	30.00
Baking powder	3.00
Salt	1.00
Water	Variable

Source: Olugbemi, (1995) [15].

Fat and sugar were creamed together until fluffy. Then flour and baking powder were added and manually mixed in a bowl to form dough. The dough was then rolled to a uniform thickness on a rolling board and cut to a uniform diameter using a cookie cutter. The batter was shaped using condensed milk tins (0.30 x 0.35mm) and baked in an oven at 180°C for 20 minutes. The biscuits were then removed from the oven, allowed to cool on a rack, and packaged in low-density polyethylene bags and stored in lidded plastic containers at room temperature.

ANALYSES

Chemical Properties of Biscuits

Moisture content, crude protein, crude fat, crude fibre, and ash contents were determined by the methods of AOAC [16]. Carbohydrate content was determined by difference [17].

Physical Properties of Biscuits

Biscuit diameter (D) and thickness (T) were determined by the Method of AACC [18] using a caliper. Diameter was measured by placing six (6) biscuits horizontally edge-to-edge; while thickness was measured by stacking six (6) biscuits on top of each other and taking the average width and thickness respectively. Biscuit weight was determined using a digital electronic weighing balance (Metra, model TL 600). Spread Factor was calculated according to [1] as:

$$SF = (D/T \times CF) \times 10.$$

Where: CF= Correction Factor at Constant Atmospheric Pressure (in this case 1.0).

Sensory Evaluation of Biscuits

Sensory evaluation was carried out using the method of Meilgaard [19]. Biscuit samples were

presented to twenty (20) panelists, who were trained and instructed to observe the colour, texture, flavour and overall acceptability of the products using a 9–point hedonic scale in which 1: represented ‘dislike extremely’ and 9: represented ‘like extremely’. The 100% Wheat Flour biscuits were used as control.

Statistical Analysis

All analyses were conducted in triplicate. The data collected was subjected to analysis of variance (ANOVA) and the means were separated using pre-packaged computer statistical software (MINITAB 15).

RESULTS

Chemical Properties of Biscuits

The effect of substitution with defatted sesame flour on the chemical composition of biscuits is shown in Table 3. While there was significant increase ($p < 0.05$)

in moisture, crude protein, crude fat, crude fibre and ash contents, carbohydrate content decreased significantly ($p < 0.05$) with increase in sesame flour substitution with values ranging from 10.20 to 16.84%, 2.08 to 5.23%, 1.20 to 2.66%, 1.37 to 2.03% and 76.45 to 63.53% respectively.

Physical Properties of Biscuits

The effect of wheat flour substitution with defatted sesame flour on the physical properties of biscuits is shown in Table 4. There was general increase in the weight of the biscuits, with values ranging from 9.35 to 9.86 g with increase in the proportion of defatted sesame flour though it was not significant ($p > 0.05$). However, there was significant ($p < 0.05$) increase in diameter and spread factor as well as a decrease in thickness with increase in sesame flour, with values ranging from 4.30 to 4.83 cm, 30.07 to 58.19 and 1.43 to 0.83 cm respectively.

Table 3: Proximate Composition of Biscuits from Blends of Wheat and Sesame Flours (%)

Parameter	Moisture	Crude Protein	Crude Fat	Crude Fibre	Ash	Carbohydrate
A	8.50 ^b ±0.35	10.20 ^d ±0.50	2.08 ^d ±0.08	1.20 ^c ±0.15	1.37 ^b ±0.20	76.45 ^a ±0.60
B	8.74 ^b ±0.45	12.67 ^c ±0.67	3.23 ^c ±0.15	1.44 ^c ±0.10	1.48 ^b ±0.20	72.30 ^b ±0.70
C	9.15 ^a ±0.30	14.53 ^b ±0.45	4.03 ^b ±0.15	2.03 ^b ±0.25	1.89 ^a ±0.10	68.28 ^c ±1.05
D	9.55 ^a ±0.30	16.84 ^a ±0.25	5.23 ^a ±0.14	2.66 ^a ±0.17	2.03 ^a ±0.10	63.53 ^d ±0.185
LSD	0.80	0.88	0.56	0.48	0.35	1.50

Values are Means ± Standard deviations of triplicate determinations.

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

Key:

A – 100% Wheat Flour biscuits (Control).

B – 90% Wheat Flour + 10% Defatted Sesame Flour biscuits.

C – 80% Wheat Flour + 20% Defatted Sesame Flour biscuits.

D – 70% Wheat Flour + 30% Defatted Sesame Flour biscuits.

LSD – Least Significant Difference.

Table 4: Physical Properties of Biscuits from Blends of Wheat and Sesame Flours

Parameter	Weight (g)	Diameter (cm)	Thickness (cm)	Spread Factor
A	9.35 ^a ±0.13	4.30 ^b ±0.10	1.43 ^a ±0.06	30.07 ^d ±0.07
B	9.44 ^a ±0.41	4.43 ^b ±0.12	1.25 ^a ±0.05	35.44 ^c ±0.05
C	9.56 ^a ±0.24	4.57 ^a ±0.12	1.05 ^a ±0.10	43.52 ^b ±0.50
D	9.86 ^a ±0.33	4.83 ^a ±0.15	0.83 ^b ±0.15	58.19 ^a ±0.25
LSD	0.53	0.34	0.45	3.48

Values are Means ± Standard deviations of triplicate determinations.

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

Key:

A – 100% Wheat Flour biscuits (Control).

B – 90% Wheat Flour + 10% Defatted Sesame Flour biscuits.

C – 80% Wheat Flour + 20% Defatted Sesame Flour biscuits.

D – 70% Wheat Flour + 30% Defatted Sesame Flour biscuits.

LSD – Least Significant Difference.

Table 5: Mean Sensory Scores of Biscuits from Blends of Wheat and Sesame Flours

Parameters	Colour	Aroma	Taste	Texture	Acceptability
A	6.30 ^b	6.05 ^c	6.40 ^b	5.85 ^c	6.15 ^b
B	7.15 ^a	6.45 ^a	7.35 ^a	6.75 ^b	7.25 ^a
C	7.35 ^a	6.20 ^b	6.25 ^b	7.05 ^a	6.40 ^b
D	6.15 ^b	5.40 ^a	5.50 ^c	6.10 ^{bc}	5.70 ^c

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

Key:

A – 100% Wheat Flour biscuits (Control).

B – 90% Wheat Flour + 10% Defatted Sesame Flour biscuits.

C – 80% Wheat Flour + 20% Defatted Sesame Flour biscuits.

D – 70% Wheat Flour + 30% Defatted Sesame Flour biscuits.

Sensory Evaluation of Biscuits

The mean scores of sensory attributes of the biscuits are given in Table 5. Scores for all the attributes increased significantly ($p < 0.05$) with increase in sesame substitution up to the 80:20 substitution levels and then declined at the 70:30 levels. The biscuits became lighter in colour with increase in quantity of defatted sesame flour, with scores increasing from 6.30 in 100% wheat to 7.35 in 80:20 blends and then declining to 6.15 in 70:30 blend. Scores for aroma, taste and texture of the biscuits followed the same trend as that of colour.

DISCUSSION

Chemical Properties of Biscuits

The significant increase ($p < 0.05$) in moisture, crude protein, crude fat, crude fibre, ash and decrease in carbohydrate contents with increase in sesame flour substitution could be due to substitution effect consistent with the higher levels of protein, fat, fibre and minerals, as well as the lower carbohydrate content of sesame as compared to wheat flours. A similar finding was also reported when bread was produced from a composite flour of wheat and soybeans [20].

Proteins are essential constituents of all body tissues, which help the body to produce new tissues. They are therefore extremely important during growth, pregnancy and when recovering from wounds. Fats, especially the unsaturated type found in sesame [11], apart from being a source of energy also provide other very 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 [1]. 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. These plant food materials include non-starch polysaccharides such as celluloses, some hemi-celluloses, gums and pectin as well as resistant starches [21]. Ash content is an indication of 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.

Physical Properties of Biscuits

Physical analysis of biscuits is very important for both consumers and manufacturers. The spread of the biscuits should be according to specification. Too much elasticity (gluten) in the dough will spring back to give thicker biscuits with smaller diameter; while too little elasticity may cause dough to flow after molding, resulting in thin biscuits with larger diameter [1].

The increase in the weight of the biscuits could be as a result of imbibitions of water due to the higher water absorption/ retention capacity of the sesame flour, as observed from the gradual increase in the moisture content of the biscuits from the blends. The significant ($p < 0.05$) increase in diameter and spread factor as well as a decrease in thickness with increase in sesame flour could be due to the reduction in gluten content (elasticity) with increase in sesame flour. This is in agreement with Mian *et al.* [1] who reported that the decrease in elasticity of batter (decrease in gluten content) may cause batter to flow after molding, resulting in large diameter and thin biscuits. Increase in diameter and decrease in thickness will lead to increase in spread factor.

Sensory evaluation of Biscuits

In baking colour serves as a cue for doneness of the food and is correlated with changes in

aroma/flavour. Colour changes might be due to caramelization, dextrinization of starch or Millard reactions involving the interaction of reducing sugars with proteins [5]. The change in colour could therefore, have resulted from the decreasing level of carbohydrate (sugar) with the addition of sesame thereby reducing the level of caramelization, which brings about the brown colour.

The decline in aroma at highest level of substitution of defatted sesame could be due to the strong nutty smell associated with sesame flour; while that of texture could be due to the decrease in gluten content with increased defatted sesame flour there by reducing the crispiness of the biscuits. Texture is extremely important to the consumer. Unlike colour and flavour, texture is used by the consumer, not as an indicator of food safety, but as an indicator of food quality [1]. Taste is a sensation perceived by the tongue and is influenced by texture, flavour and the composition of the food.

Flavour, taste and colour were found to be the determining factors for acceptability of the biscuits. Biscuits from 90% WF +10% Defatted Sesame blend were significantly ($p < 0.05$) more acceptable than all the others including 100% WF. This could be due to the enhanced flavour (nutty aroma) imparted by the sesame flour.

CONCLUSION

This study has shown that substitution of Wheat flour with up to 10% defatted sesame flour can give composite flours that will produce biscuits with enhanced nutritional composition in terms of protein, fat, fibre and mineral content, which could be of even higher acceptability than 100% wheat flour.

REFERENCES

[1] Mian KS, Masood SB, Faqir MA, Haq N. Preparation of fiber and mineral enriched defatted rice bran supplemented biscuits. *Pakis. J. Nutri*, 2009; 8 (5): 571–577.

[2] Ubbor SC, Akobundu ENT. Quality characteristics of biscuits from composite flours of watermelon seed, cassava and wheat. *Pakis. J. Nutri*, 2009; 8(7): 1097–1102.

[3] Akubor OI. Protein content, physical and sensory properties of biscuits prepared from soybean / maize flour blends. In: Proceedings of the 28th Annual Conference and AGM of the

Nigerian Institute of Food Science and Technology (NIFST) 2004; P 46–47.

[4] Chima EC, Gernah DI. Physico-chemical and sensory properties of biscuits produced from cassava /soybean/mango flour blends. *J. Food Technol.*, 2005; 5 (3): 256–260.

[5] Butt MS, Sharif V, Nasir M, Iftikhar M, Rehman K. Preparation and quality evaluation of biscuits containing sweet potato flour. *Indus J. Plant Sci.*, 2004; 3: 69–76.

[6] Gernah DI, Akogwu MA, Sengeve AI. Quality evaluation of cookies produced from blends of wheat and african locust beans (*Parkia biglobosa*) fruit pulp flours. *Nig. J. Nutr. Sci.*, 2010; 31 (2): 20–24.

[7] Gernah DI, Sengeve IA, Audu JO. Physico – chemical and sensory evaluation of biscuits produced from wheat and Brewers' Spent Grain (BSG) composite flours. *Nig. Food J.*, 2010; 28 (2): 440–447.

[8] Ogazi PP. The biscuit making potential of plantain (flour/pulp). *Nig. Food J.*, 1985; 3 : 2–3.

[9] FAO. Production Crops: Sesame Seeds. Food and Agriculture Organization of the United Nations, Rome, 2012.

[10] Adeyemo SO, Oloyede OB, Odutuga AA. Biochemical analysis of germinating white maize (*Zea mays*), *Nig. J. Nutr. Sci.*, 1992; 13 (1&2): 18–24.

[11] Woltman O. Sesame Seed. International Dipasa Group. www.dipasa.nl 2000; pp 1–3

[12] Gernah DI. Quality evaluation of food formulations from malted and fermented maize (*Zea mays* L.) fortified with defatted sesame (*Sesamun indicum* L.) flours. Ph.D Thesis, Department of Food Science and Technology, University of Agriculture, Makurdi, 2008.

[13] Ramachandra BS, Sastry MCS, Subba – Rao LS. Process development studies on the wet dehulling and processing of sesame seed to obtain edible protein concentrates. *J. Food Sci. Technol.*, 1970; 7: 127–131.

[14] Visser A, Thomas A. Soya protein products-their processing, functionality and application aspects. *Food Rev. Intl.*, 1987; 31(182): 1–32.

[15] Olugbemi LB. Current Status and Prospects of Composite Flour Technology with Particular Reference to Sorghum Bread and Biscuits. Menyonga J.M, Bezuneli T, Nwasika CC, Sidips LM, Tenkauna A editors. OAU – SAFRAO Publication, Burkina Faso, 1995; pp 35–42.

[16] AOAC. Official Methods of Analysis, 16th ed. Association of Official Analytical Chemists, Arlington, V.A., 2012; pp806–842.

[17] Ihekoronye AI, Ngoddy PO. Integrated Food Science and Technology for the Tropics. MacMillan Publishers, New York, 1985; pp 296–301.

[18] AACC. Approved Methods of the American Association of Cereal Chemists. 10thed. The Association: St. Paul, MN; 1995.

[19] Meilgaard MC, Civille GV, Carr BT. Sensory Evaluation Techniques, 4th ed. C.R.C.Press L.L.C., New York., 2007.

[20] laoye OA, Onilude AA, Idowu OA. Quality characteristics of bread produced from composite flours of wheat, plantain and soyabeans. *Afric. J Biotech.*, 2005; 3 (11): 1102–1106.

21. DeVries JW. AACC Report: The definition of dietary fibre. *Cereal Foods World*, 2001; 46: 112–126.