World Nutrition, June 2026;17(2): 24-32
DOI: https://doi.org/10.26596/wn.202617224-32

WORLD NUTRITION
The Official Journal of the World Public Health Nutrition Association
Journal homepage: https://www.worldnutritionjournal.org
WPHNA
ISSN: 2041-9775

Research Article

Development, nutritional composition, consumer acceptability, and glycaemic response of biscuits produced from plantain and tigernut flour blends

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OPEN ACCESS

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Article History
Received: February 25, 2026
Reviewed: March 11, 2026
Revised: March 21, 2026
Accepted: April 14, 2026
Published: June 30, 2026

Citation
Yahaya B.O., Ejoh S.I., Ogundele A. E., & Adebayo-Oke B.O. (2026). Development, nutritional composition, consumer acceptability, and glycaemic response of biscuits produced from plantain and tigernut flour blends. *World Nutrition*, 17(2), June, 24–32. https://doi.org/10.26596/wn.202617224-32

Academic Editor
Ted Greiner, PhD

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Highlights/Key Messages

- The study shows that the biscuits made from various ratios of tigernut flour and plantain flour can be classified as low GI and low GL foods.
- The biscuits could thus offer a healthy snacking option for those with metabolic issues.
- The biscuits could also serve as a gluten-free alternative to wheat biscuits.

Background
There is a rise in demand for ready-to-eat healthy snacks, prompting scientific innovation in developing snacks made from balanced, nutrient-rich plant materials with no adverse health effects.

Objective
The aim of the study was to examine the nutrient content, sensory properties, and glycaemic response (GR) -- (glycaemic index (GI) and glycaemic load (GL)) -- of biscuits made from various blends of tigernut flour (TNF) and semi-ripe plantain flour (PF).

Methods
This was an experimental study involving processing of plantain and tigernuts into flours and formulations of biscuits containing varying ratios of PF and TNF (50:50, 100:0, and 0:100) with whole wheat biscuit used as control; measurement of the proximate content of the biscuits; a 30-panelist sensory evaluation; and GI and GL test among 15 apparently healthy participants. The area under the curve for the test and reference foods was calculated using the trapezoidal rule. ANOVA ($p < 0.05$) was used to express the statistical differences between the means obtained for the three types of biscuit samples analysed.

Results
Moisture content ranged from 5.32% ± 0.01% to 11.27% ± 0.02% and carbohydrate from 53.05% ± 0.09% to 59.43% ± 0.1%. Biscuits containing flour ratios of PF0:TNF100 showed the highest overall acceptability score, 6.40±0.25. The GI calculated was higher (50) for the control biscuit than that of the biscuits with flour ratios PF50:TNF50 and PF0:TNF100 (34 and 16, respectively). The GL was 33 for the control biscuit, 15 for PF50:TNF50 and 6 for PF0:TNF100.

Conclusion
Biscuits made with PF and TNF had lower GI and GL than the control and were generally accepted by the panellists. Hence, using one or both types of flour could be an effective vehicle for glycaemic control among people who consumed substantial amounts of biscuits

Keywords: plantain flour, tigernut flour, glycaemic index, glycaemic load, biscuits, healthy snack, nutrient content

Introduction

There are differences in the glycaemic response (GR) when carbohydrate-rich foods are consumed, though also measured by glycaemic indices (GI) and glycaemic load (GL) (Gelencsér et al., 2008). GR involves the time and various levels of blood glucose after consumption of test foods. Values recorded on the basis of time and changes in blood glucose (GR) are then coded and means calculated (Amadi et al., 2019). Low-glycemic index foods are recognised as such for their health benefits due to their metabolic effects, with a focus on their capacity to slow the rate at which glucose is absorbed or taken up from the small intestine (Kendall et al., 2006). Because the postprandial blood glucose response is determined by both the GI and the quantity of carbohydrates consumed, GI and GL are essential parameters for classifying carbohydrate-containing foods (Salari-Moghaddam et al., 2019; Kumar et al., 2022).

Snacking is a common global dietary habit, with biscuits dominating the fast-moving consumer goods sector (Arora et al., 2020; Goubgou et al., 2021). Although biscuits can be an effective means of nutrient delivery, traditional types are mostly made from refined wheat flour (Canalis et al., 2017). These types of biscuits pose problems for those with gluten intolerance and those sensitive to the high GI of refined cereals, contributing to chronic nutritional-related diseases (Adegunwa et al., 2017; Goubgou et al., 2021).

To address these limitations, research has shifted towards gluten-free, nutrient-dense alternatives to traditional foods, such as plantain flour (PF) and tigernut flour (TNF). Recent studies have demonstrated that composite flours (e.g., corn–bean blends) can reduce the GI and improve nutritional quality, although challenges remain in balancing sensory and functional properties (Mejía-Terán & Blanco-Lizarazo, 2020). Similarly, a formulation using soybean flour and resistant starch have shown improvements in fibre content and GR, highlighting the growing interest in functional cookie design (Lin et al., 2025).

Plantain is a carbohydrate-rich traditional staple in Nigeria, abundant in resistant starch and dietary fibre, making it an ideal choice for diabetic diets (Akinyemi et al., 2008; Udo et al., 2021). Similarly, Tigernut is a nutrient-dense traditional nut rich in essential minerals, healthy fats, and vitamins (Twumasi et al., 2023). Tigernut flour is also high in dietary fibre, lipids, and phenolic compounds, and its inclusion in baked goods has been shown to enhance bioactive content while retaining acceptable sensory qualities (Elfadıl et al., 2021). Both ingredients have a mild natural sweetness that can reduce or eliminate the need for added sugars in confectionery (Adegunwa et al., 2017; Kuznetsova et al., 2021).

While previous studies have examined the proximate composition of tigernut-plantain blends (Gbenro et al., 2023; Adegunwa et al., 2017), there is limited empirical data on the actual postprandial GR in humans. Furthermore, most "healthy" biscuit formulations still utilise sucrose as a primary ingredient (Chavan et al., 2016). This study addresses this gap by developing a biscuit that entirely replaces added sugar with the natural sweetness of stage-3 (slightly yellow) matured traditional plantains and tigernuts. Although past research (Lin et al., 2025; Gbenro et al., 2023) has explored the development of low-glycaemic cookies using cereal–legume composite flours, there remains limited evidence on the GR of products made from plantain–tigernut blends. The present research evaluates the in vivo GR and functional potential of biscuits produced from these underutilised crops.

Methods

Study Design and Location

An experimental research design was used to develop and assess functional biscuits made from blends of plantain and tigernut flours. The study comprised four phases: flour processing and biscuit production, proximate analysis, sensory evaluation, and GR testing. All laboratory procedures and clinical tests were conducted at the Department of Human Nutrition and Dietetics, University of Ibadan, Nigeria.

Phase 1: Flour Processing and Biscuit Production

Raw Material Procurement and Preparation

Plantain flour (PF) processing

Unripe plantain fruits (Musa paradisiaca) were purchased from a popular traditional food market (Oje) in Ibadan, Oyo State. The fruits were ripened under ambient conditions until they reached Stage 3 (slightly yellow) on the ripening scale. The ripe plantains were peeled and sliced into pieces approximately 5 mm thick with a kitchen knife. The sliced pieces were dried at 60°C for 24 hours in an oven (Binatone electric oven). The dried samples were then milled into coarse flour using a Senweimax GX200 grinder and subsequently ground into fine flour with a Philips dry blender. The processed plantain flour was stored in airtight zip-lock polyethene bags at room temperature for analysis and future use.

Tigernut flour (TNF) processing

The samples (7kg after processing) were carefully sorted, washed, and oven-dried at 103°C for 1 hour in an Ignis kitchen oven at the dietetic kitchen facility of the Department of Human Nutrition, University of Ibadan. They were then ground into flour using a Senweimax GX200 grinder. After processing, the flour was stored in an air-tight zip-lock polythene bag at room temperature for analysis and subsequent procedures.

Biscuit Preparation and Production

The biscuit was made using the method illustrated in Figures 1 and 2. Biscuit formulations employed different composite ratios of PF and TNF (100:0, 50:50, and 0:100), with whole-meal wheat flour biscuits acting as the experimental control.

The first step was manually mixing all dry ingredients, including composite flour, baking powder, baking soda, powdered milk, guar gum, and ginger powder, in a dry bowl. After this, margarine, egg, coconut flavour, and water were added and mixed until fully incorporated. The dough was then kneaded by hand for an additional five minutes to ensure uniform mixture of all ingredients. Table 1 lists all ingredients and quantities used in the biscuit formulation. The batter was then rolled out on a clean surface, cut into circular shapes, and placed on a baking tray, then baked in a

preheated (Ignis kitchen oven) at approximately 180°C for 20 to 25 minutes. After baking, the biscuits were allowed to cool at room temperature, then packed and stored in airtight plastic bags for further analysis. We made biscuits made from wholemeal wheat flour to serve as the control.

Study Population and Selection Criteria

Participants were recruited from the University of Ibadan using convenience sampling. The group consisted of apparently healthy young adults (ages 18–35 years). A total of 30 participants were recruited for the sensory evaluation phase, and a subset of 15 volunteers took part in the GR test in accordance with ISO 26642:2010.

Inclusion and Exclusion Criteria

Participants had to be non-pregnant, non-lactating, and free from diabetes mellitus or known allergies to the study ingredients. Those taking medications that affect glucose metabolism or outside the 18–35 age range were excluded.

Phase II: Sensory Evaluation and Acceptability

The sensory profile of the formulated biscuits was evaluated by a panel of 30 untrained participants. A 9-point hedonic scale (ranging from 1 = "dislike extremely" to 9 = "like extremely") was used to assess five key attributes: appearance, aroma, taste, texture, and overall liking. Samples were assigned random 3-digit codes and presented in random order. Bottled water was provided for palate cleansing between samples.

Phase III: Proximate Analysis

The nutritional composition of the biscuit samples was analysed following standardised AOAC (2012) protocols. Analysis was performed in triplicate to measure moisture, ash, crude protein, crude fibre, crude fat, and total carbohydrate (calculated by difference).

Phase IV: Determination of Glycaemic Response

The GR was determined following the protocols described by ISO (2010), Jarrar et al. (2019), and Brouns et al. (2005).

Screening: Volunteers underwent thorough screening, including anthropometric measurements (height and weight), clinical assessments (blood pressure and malaria tests), and biochemical evaluations (blood glucose and urinalysis for glucose and protein).

Pre-test restrictions: Participants were advised to avoid alcohol, caffeine, and vigorous physical activity for at least 24 hours before each test session and to have a standardised evening meal prior to an overnight fast (10–12 hours).

Test-day protocol: A crossover dietary design was utilised. On the first day, participants consumed a reference food consisting of 50g of Glucose D powder dissolved in 300ml of water. Following a one-day washout period for each sample, they ate test portions of the two biscuit formulations with the highest fibre content and acceptability—specifically PF50:TNF50 and PF0:TNF100—from the previously described sensory evaluation and proximate analysis, along with a commercial "no-sugar" whole wheat biscuit serving as a control. Test foods were administered in random order across study days to minimise order effects. All tests were carried out in the morning under standardised conditions. On separate days following a 1-day washout, participants consumed test foods containing 50 g of available carbohydrates. The fingertips of participants were wiped clean using cotton wool already dipped in methylated spirit. A sterilised lancet was used to prick the cleared area of the participant's finger. An active Accu-check Active® glucometer strip was inserted into the Accu-check Active® glucometer, which was used to collect the blood sample from the fingertip, and the glucose level was read on the glucometer. A dry cotton swab was given to the participants to stop blood flow. Blood glucose levels were measured every 30 minutes over a two-hour period.

Reference food testing: The reference food (glucose) was administered twice to each participant, and the average response was utilised in the GI calculation.

Blood glucose monitoring: Portion sizes were standardised to provide exactly 50g of available carbohydrates. Capillary blood glucose levels were measured at 0, 30, 60, 90, and 120 minutes after consumption using an Accu-check Active® glucometer.

Data Analysis and GI Classification

Data were analysed using IBM SPSS Version 20. The Incremental Area under the Curve (IAUC) was calculated in Microsoft Excel using the trapezoidal rule. Baseline blood glucose (fasting value) served as the reference point, and only incremental areas above baseline were included; negative areas (below baseline) were excluded from the calculation. Statistical significance was evaluated via One-way Analysis of Variance (ANOVA) at $p < 0.05$, followed by Duncan's Multiple Range Test for mean comparisons in the sensory and proximate analysis.

Glycaemic Index (GI): Calculated as $Glycemic\ Index = \frac{Test\ Food\ IAUC}{Glucose\ IAUC} \times 100$

Glycaemic Load (GL): Calculated as $Glycemic\ load = \frac{GI \times \text{Available carbohydrate in a serving}}{100}$

Classification aligned with international standards: Low-GI is ⩽55; 56 to 69 have a moderate effect; and high-GI foods (70 to 100) have a notable effect (Atkinson et al., 2021; Lal et al., 2021).

Classification of GL was ⩽ 10 (low); 11-19 for medium GL, and ⩾ 20 for high GL (Salari-Moghaddam et al., 2019).

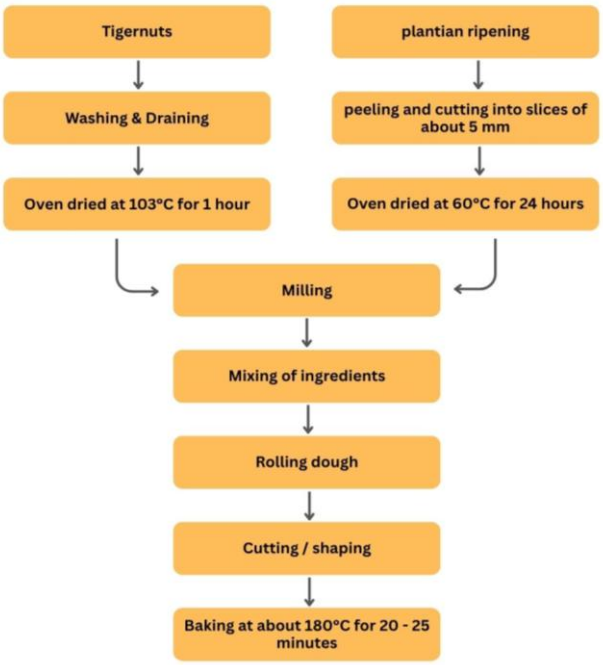


Figure 1. Flowchart of biscuit preparation



Figure 2. Images showing raw plantain into processed plantain flour

The cookie recipe was adopted and modified for developing the biscuit recipe and formulations for this study.

Table 1. Biscuit formulation and recipe

Ingredients	Samples (quantities)			
	Control	A	B	C
Plantain flour (g)	-	125	0	250
Tigernut flour (g)	0	125	250	0
Wholemeal Wheat flour (g)	250	-	-	-
Dano skimmed Milk (g)	5	5	5	5
Sodium bicarbonate (g)	1	1	1	1
Baking powder (g)	1	1	1	1
Guar gum (g)	2	2	2	2
Ginger powder (g)	1.5	1.5	1.5	1.5
Margarine (g)	80	80	80	80
Whole Egg (medium – 49 -51g)	1	1	1	1
Coconut flavour (ml)	5	5	5	5
Water (ml)	40	40	40	40

*Description: formulations of Plantain Flour: Tigernut Flour in the ratios (A=50:50, B=0:100, C=100:0).

Ethical Considerations

Ethical clearance was approved by the UI/UCH Health Research Ethics Committee (Approval No: UI/EC/24/0787). Written informed consent was obtained from all participants before recruitment.

Proximate composition of biscuits from different formulations of tigernut and plantain flour

Proximate Composition of the biscuits made from different formulations of tigernuts and plantain flour is displayed in Table 2. There were some significant differences ($p < 0.05$) in the proximate content of the formulations across all measured food properties.

Table 2. Proximate composition of biscuits from plantain and tigernut composite flour

Sample	Control	PF_{50}:TNF_{50}	PF_0:TNF_{100}	PF_{100}:TNF_0
Moisture Content (%)	5.32 ± 0.01^a	7.22 ± 0.01^c	5.99 ± 0.01^b	11.27 ± 0.02^d
Crude Protein (%)	13.72 ± 0.07^c	8.83 ± 0.07^b	8.91 ± 0.07^b	7.29 ± 0.07^a
Crude Fat (%)	19.39 ± 0.01^b	23.42 ± 0.01^c	30.40 ± 0.01^d	19.30 ± 0.01^a
Total Ash (%)	2.28 ± 0.02^b	2.24 ± 0.01^b	1.66 ± 0.01^a	2.72 ± 0.02^c
Crude Fibre (%)	0.82 ± 0.02^a	13.41 ± 0.01^c	16.53 ± 0.03^d	2.62 ± 0.02^b
Total Carbohydrate (%)	59.29 ± 0.06^c	58.28 ± 0.06^b	53.05 ± 0.09^a	59.43 ± 0.10^c

n=3
PF – Plantain flour, TNF – Tigernut flour, n – analytical replicates
Values are means of triplicate determinations. Mean values with different superscripts within a column are significantly different ($p<0.05$).

Sensory evaluation score and consumer acceptability of biscuits from plantain and tigernut composite flour

The consumer acceptability of biscuits made from different formulations of tigernut and plantain flour is shown in Table 3. There were significant differences ($p<0.05$) in the acceptability scores for all sensory attributes except for texture.

The control sample made from 100% wheat flour scored highest for appearance, colour, and texture. Biscuits made with flour ratios of PF0:TNF100 and control biscuits scored highest for aroma, while PF50:TNF50 scored the highest for taste. PF0:TNF100 and PF50:TNF50 received the highest scores for overall acceptability. Biscuit samples from PF0:TNF100 had the highest overall score; PF100:TNF0, the lowest.

Table 3. Sensory score and consumer acceptability of biscuit from plantain and tigernuts composite flour

Sample	Control	PF_{50}:TNF_{50}	PF_0:TNF_{100}	PF_{100}:TNF_0
Appearance	6.83 ± 0.17^c	5.87 ± 0.25^{ab}	6.43 ± 0.26^{bc}	5.26 ± 0.32^a
Colour	6.63 ± 0.16^c	5.83 ± 0.23^{ab}	6.27 ± 0.25^{bc}	5.53 ± 0.29^a
Aroma	6.83 ± 0.23^b	6.70 ± 0.22^b	6.83 ± 0.24^b	5.80 ± 0.36^a
Texture	6.23 ± 0.29^a	5.73 ± 0.30^a	5.53 ± 0.28^a	5.37 ± 0.29^a
Taste	5.70 ± 0.31^a	6.67 ± 0.27^b	6.20 ± 0.29^{ab}	5.33 ± 0.31^a
Overall acceptability	6.23 ± 0.23^{ab}	6.37 ± 0.24^b	6.40 ± 0.25^b	5.57 ± 0.27^a

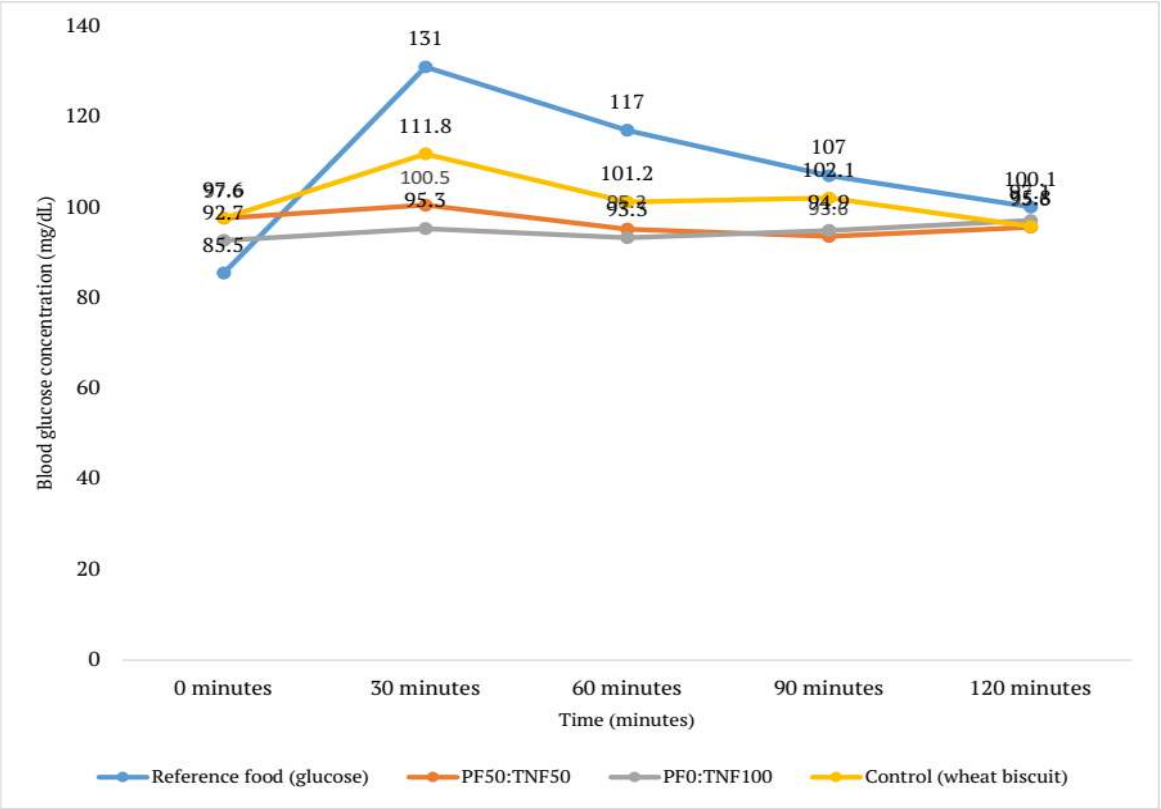
n = 30
*PF – Plantain flour TNF – Tigernut flour, n= panel size
Mean values with different superscripts within a column are significantly different ($p<0.05$)

Blood Glucose Responses

As shown in Figure 3, all test foods increased blood glucose at 0 and 30 minutes post-consumption. The control biscuit (wheat biscuit) showed the highest post-prandial blood glucose rise (111.8±14.88 mg/dl), peaking at 30 minutes. Biscuits containing PF0:TNF100 exhibited the smallest

increase in post-prandial blood glucose (97.10±6.84 mg/dl), which peaked at 120 minutes, indicating a slower rise in blood glucose levels after consumption.

Participants' responses to biscuits containing PF50:TNF50 also showed a gradual rise in blood glucose levels, peaking at 30 minutes (100.50±6.02 mg/dl) and then steadily declining thereafter.



n = 10 for each curve. PF – Plantain flour TNF – Tigernut flour

Figure 3. Glycaemic response curve of all biscuit formulations

Glycaemic Index and Load

Table 4 shows the GL of the test biscuits. The biscuit sample with a flour-to-TNF ratio of PF0:TNF100 has the lowest GI and GL.

Table 4. Glycaemic index and load of biscuit samples.

Food Sample	Glycaemic Index			Glycaemic Load (%)		
	Low	Moderate	High	Low	Medium	High
$PF_{50}:TNF_{50}$	34				14	
$PF_0:TNF_{100}$	16			6		
Control (wheat biscuit)	50					30

Low-GI is ⩽ 55; 56 to 69 have a moderate effect, and high-GI foods (70 to 100) have a significant effect (Atkinson et al., 2021; Lal et al., 2021).
GL classification: ⩽ 10% (low); 11-19% for medium GL, and ⩾20% for high GL (Salari-Moghaddam et al., 2019).

Discussion

This study aimed to develop a nutrient-rich biscuit snack using composite flour blends of plantain and tigernut, with the goal of offering a healthier alternative to traditional snack products. The product was created as a functional snack option with potential benefits for enhanced glycaemic control and weight management, owing to the nutritional and dietary qualities of the selected plant-based ingredients. The proximate composition was compared among four biscuit formulations: the control (wheat-based), PF50:TNF50 (50% plantain flour: 50% tigernut flour), PF0:TNF100 (100% tigernut flour), and PF100:TNF0 (100% plantain flour), along with their sensory properties, GR, GI, and GL.

Moisture content varied considerably, with the control recording the lowest value and PF100:TNF0 the highest. This suggests that plantain's greater water-binding capacity will likely influence shelf stability. However, moisture content decreased significantly as the proportion of tigernuts increased, which could be due to the water-binding capacity of the tigernut starch molecules (Teferra et al., 2015; Ubbor et al., 2022). Our results, based on ripened plantain, are slightly higher than those of Gbenro et al. (2023), who reported moisture contents of 1.65-6.30% for biscuits made from tigernut flour and unripe plantain.

In this study, protein content decreased from 13.72% in the control (wheat gluten) to 7-9% in the three blends, reflecting a typical reduction in gluten-free formulations, yet remaining close to the recommended 10% RDA of calories for an adult. The protein levels observed in this study (8.58–9.06%) align with those reported by Ubbor et al. (2022) for biscuits made from flour blends containing 60–75% wheat flour, 10% tigernut, and 20-30% orange flesh sweet potato. These values are higher than the 4.4–6.4% reported by Adeyeye and Akingbala (2015) for cookies made from maize-sweet potato flour blends.

Crude fat content rises with tigernut inclusion due to the high levels of monounsaturated and polyunsaturated fatty acids in tigernut (Yu et al., 2022). Oleic acid, the primary fatty acid in tigernut oil (Sánchez-Zapata et al., 2012), plays a key role in preventing insulin resistance and type 2 diabetes by reducing glucolipotoxicity and oxidative stress (Sivri and Akdevelioğlu, 2025). It also supports the functions of β-cells, endothelial cells, and the hypothalamus (Prasad et al., 2022). Additionally, it enhances insulin sensitivity by increasing adiponectin levels and activating related genes; it may also encourage fatty acid oxidation by elevating carnitine palmitoyl transferase 1 (Coll et al., 2008) and assist in regulating glucose transport to muscles (Palomer et al., 2018; Sarabhai et al., 2022). Oleic acid reduces mitochondrial ROS production, thereby preventing the disruption of insulin signalling caused by palmitic acid in skeletal muscle cells (Palomer et al., 2018; Yuzefovych et al., 2010). Beyond its role in managing diabetes, tigernut oil can lower low-density lipoprotein cholesterol (LDL-C), increase high-density lipoprotein cholesterol (HDL-C), decrease blood triglycerides, and lower the risk of blood clots and arteriosclerosis (Sánchez-Zapata et al., 2012). Furthermore, it may promote calcium absorption in bones and stimulate new bone formation owing to its short- and medium-chain fatty acids, oleic acid, and essential fatty acids. Its higher oxidative stability compared to other oils, due to polyunsaturated fatty acids and gamma-tocopherol (Ezebor et al., 2005), makes it a healthier option.

Total ash, a mineral proxy, is modest, lowest in PF0:TNF100 and highest in PF100:TNF0, suggesting that plantain has a higher mineral content, including potassium and magnesium, than tigernut.

Crude fibre increases significantly in tigernut blends, with PF0:TNF100 recording the highest level. The crude fibre values for PF50:TNF50 and PF0:TNF100 (13.41±0.01 and 16.53±0.03, respectively) were considerably higher than those reported by Adegunwa et al. (2017) (6.13 ± 1.24/100 g) and Oladele and Aina (2007) (6.26/100 g) from composite flour of plantain and tigernut. However, the findings of this study align with those by Agu et al. (2023), who reported fibre contents of (7.00–11.30%) in biscuits produced from blends of whole wheat, soy okara, and tigernut residue flours. The crude fibre in the two tigernut blends exceeded 3 g of dietary fibre per 100 g, qualifying the products as sources of dietary fibre under the nutritional claims allowed for such foods. Although crude fibre has limited food value, it provides the bulk necessary for peristaltic action in the intestinal tract (Anderson, 2009).

Carbohydrate content ranges from 53.05±0.09 to 59.43±0.1, with the highest in PF100:TNF0 and the lowest in PF0:TNF100. This pattern agrees with the findings of Adegunwa et al. (2017) for a food formulation made from a blend of plantain and tigernut flours.

The control sample made from 100% wheat flour achieved the highest scores for appearance, colour, and texture. The preference for biscuits made with wheat flour may be attributed to the presence of gluten in wheat flour, which produces an elastic dough that remains firm during kneading, resulting in biscuits with improved mouthfeel, colour, and flavour (Akajiaku, 2018). The overall acceptability scores of the biscuits developed in this study were higher than those reported by Akajiaku (2018) and comparable to the score reported by Gbenro et al. (2023), who noted an acceptability score of (6.02-7.05) for all blends of biscuits made from unripe plantain and tigernut flour.

There was variability in participants' glycaemic responses to test biscuits, which is a well-documented phenomenon (Wu et al., 2025). Inter-individual variability is influenced by personal factors, such as metabolic and molecular profiles, as well as the macronutrient content of food (Wu et al., 2025; Tily et al., 2022). Additionally, the postprandial glucose response may result from differences in the rates of sugar digestion and absorption in the human body (Lal et al., 2021). The GI of the biscuits developed in this study ranged from 16 to 34%, which was lower than that reported by Oluwajuyitan and Ijarotimi (2019) for an experimental food made from plantain-based dough enriched with tigernut and defatted soybean. However, the GL (6 to 14%) recorded in this study was similar to the 6.51% to 15.1% reported in their research. The presence of fibre in both the biscuits from tigernut flour and plantain flour resulted in a significant reduction in GI—32% for PF50:TNF50 biscuits and approximately 68% for PF0:TNF100 biscuits—compared to the control biscuit made from wheat flour. These results align with those of Marangoni and Poli (2007), who reported GI values of 44 for control biscuits and 26 for fibre-enriched biscuits, a 41% reduction. The findings of this study demonstrate that the GI and GL of plantain and tigernut blends are low to moderate; therefore, these biscuits can be classified as low-GI and low-GL foods.

However, several limitations must be recognised. The study involved a relatively small sample size and included only healthy participants, which may restrict the applicability of the findings to populations with impaired glucose metabolism. Additionally, a detailed compositional analysis of the biscuits, including dietary fibre fractions and starch digestibility properties, was not conducted.

Conclusions

This study demonstrates the potential of plantain–tigernut composite flour as a functional ingredient for developing biscuits with a moderate GL. By incorporating underutilised, locally available crops, the findings support ongoing efforts to create nutritionally enhanced, lower-glycaemic snack options that may aid dietary management of metabolic

health. The glycaemic assessment revealed that the biscuits produced had significantly lower GI and GL values compared with the control wheat biscuit, indicating their potential as a functional snack for glycaemic regulation; therefore, their consumption could benefit individuals with metabolic disorders. The biscuits not only offer a healthy snacking option for those with metabolic issues but also serve as a gluten-free alternative to wheat biscuits.

Future research should focus on detailed dietary fibre profiling, in-vitro and in-vivo starch digestibility tests, enhancing specific organoleptic qualities, especially texture, conducting thorough micronutrient profiling, and shelf-life evaluation to better understand product stability and functional features. Additionally, validating glycaemic responses in target clinical groups, such as individuals with prediabetes or type 2 diabetes, is necessary to confirm the practical relevance of these products in dietary treatment interventions. Such evidence will be vital for product optimisation, large-scale production, and successful commercialisation.

Author Contributions

Conceptualization (SIE, BOY, AEO), methodology (BOY, SIE, AEO) investigation (BOY, BOA), data analysis interpretation (BOY), supervision (SIE); writing- original manuscript draft (BOY), writing – review and editing (BOY, SIE, BOA), writing-final draft (BOY, SIE). All authors have read and approved the final version of the paper and its submission and have given consent for publication.

Declaration of Generative AI and AI-Assisted Technologies in Scientific Writing

Nothing to disclose.

Acknowledgements

The authors wish to sincerely thank all the study participants, and research assistants who committed their time to participate in this study; the Department of Human Nutrition and Dietetics, University of Ibadan, the food analysis laboratory, and the medical laboratory staff and the dietetic kitchen facilities for the preparation of the test foods.

Data Availability Statement

The datasets generated and/or analysed during the current study are not publicly available due to privacy and institutional restrictions, but are available from the corresponding author on reasonable request.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interest

The authors declare that they have no conflicts of interest.

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