

DEVELOPMENT AND EVALUATION OF SESAME (SESAMUM INDICUM) FLOUR-FORTIFIED COOKIES FOR BONE HEALTH: A PHYSICOCHEMICAL AND SENSORY EVALUATION

Asifa Zain^{*1}, Hafiz Shahzad Muzamil²

^{*1}Student of Human Nutrition and Dietetics, Faculty of Allied Health Sciences, The Superior University, Lahore, Pakistan

²Department of Human Nutrition and Dietetics, Faculty of Allied Health Sciences, The Superior University, Lahore, Pakistan

^{*1}wattooasifa5@gmail.com

DOI: <https://doi.org/10.5281/zenodo.22956040>

Keywords

sesame flour; cookies; bone health; calcium fortification; sensory evaluation; functional food.

Article History

Received: 17 June 2026

Accepted: 08 September 2026

Published: 25 September 2026

Copyright @Author

Corresponding Author: *

Asifa Zain

Abstract

Osteoporosis and declining bone mineral density are growing global health concerns, particularly among post-menopausal women and older adults, highlighting the need for functional foods that supply bone-supportive nutrients through everyday diets. Sesame (*Sesamum indicum* L.) seeds are a rich natural source of calcium, phosphorus, protein, dietary fiber and bioactive antioxidants, making them a promising ingredient for fortifying widely consumed bakery products such as cookies. This study developed and evaluated cookies in which refined wheat flour was partially replaced with sesame cake flour (SCF) at five levels: 0% (T0, control), 5% (T1), 10% (T2), 15% (T3) and 20% (T4). The resulting cookies were assessed for physical properties (diameter, thickness, spread ratio, spread factor), proximate composition (moisture, crude fat, crude protein, ash, crude fiber, carbohydrate, energy), mineral content (calcium and phosphorus), sensory acceptability on a 9-point hedonic scale, and moisture/texture stability over 45 days of ambient storage. Increasing SCF substitution significantly ($p < 0.05$) increased diameter, spread ratio, fat, protein, ash, fiber, calcium, phosphorus and energy content, while thickness, moisture and carbohydrate content decreased. Calcium and phosphorus content rose several-fold at higher substitution levels. Sensory scores followed a non-linear trend, peaking at T2 (10%) for color, aroma, texture, taste and overall acceptability, and declining sharply at T4 due to over-spreading, bitterness and crumbliness. T2 also maintained the best moisture and texture stability over 45 days of storage. Based on the integration of physical, nutritional, mineral, sensory and storage results, 10% sesame cake flour substitution (T2) was identified as the optimum formulation, offering enhanced bone-supportive mineral content and nutritional value without compromising consumer acceptability, supporting its potential as a functional food for bone health promotion.

1. Introduction

Bone health is a fundamental component of overall physical wellbeing, since the skeletal system provides structural support, enables movement and protects vital organs. Bone tissue undergoes continuous remodeling through the coordinated activity of bone-forming osteoblasts and bone-resorbing osteoclasts, a process that depends on an adequate dietary supply of calcium, phosphorus, magnesium, zinc, protein and antioxidant compounds (1). Over recent decades, skeletal disorders such as osteoporosis, osteopenia and increased bone fragility have become increasingly prevalent public health concerns, driven by population ageing, sedentary lifestyles and widespread nutritional deficiencies (2). Reduced bone mineral density and deteriorating bone microarchitecture substantially raise fracture risk, particularly among post-menopausal women and older adults, underscoring the need for preventive nutritional strategies that can be sustained across the lifespan (3).

Functional foods, designed to deliver physiological benefits beyond basic nutrition, have gained considerable attention as a practical strategy for addressing micronutrient deficiencies at the population level (4). Food fortification, in particular, allows nutrient-dense ingredients to be incorporated into foods that are already part of habitual dietary patterns, making it more sustainable and accessible than standalone supplementation (5). Bakery products are especially suitable vehicles for fortification because of their affordability, long shelf life, wide consumption across age groups and formulation flexibility (6). Cookies, in particular, are a popular snack food that can be readily reformulated to carry nutrient-dense ingredients while remaining convenient and palatable, making them an attractive target for nutritional enhancement aimed at bone health (7).

Sesame (*Sesamum indicum* L.) is among the oldest cultivated oilseed crops and possesses a nutritional profile particularly suited to bone-health-oriented fortification (8). Sesame seeds are rich in protein, unsaturated fatty acids and dietary fiber and, notably, calcium, phosphorus, magnesium, iron

and zinc, minerals directly implicated in bone mineralization and skeletal maintenance (9). Beyond its mineral content, sesame also contains bioactive lignans, including sesamin, sesamolin and sesamol, along with tocopherols and phenolic antioxidants that may help counter the oxidative stress associated with osteoclast activation and bone loss (10, 11). The residual material remaining after oil extraction, sesame cake flour, retains much of this nutritional value and represents both a functional fortification ingredient and a means of valorizing an agricultural by-product, making it a promising candidate for incorporation into cookies formulated to support bone health (9).

Existing evidence supports a meaningful role for food fortification in supporting skeletal health. Rizzoli (1) emphasized that adequate nutrition underpins bone development and the maintenance of bone mass throughout adulthood, while Ilich and Kerstetter (2) argued that calcium intake alone is insufficient to explain bone metabolism, highlighting the additional contributions of protein, antioxidants and trace minerals. In a scoping review of 24 randomized controlled trials, Whiting et al. (3) reported that calcium- and vitamin D-fortified foods were associated with improved bone mineralization and reduced bone turnover, particularly in adults over 50 years and post-menopausal women, although the effectiveness of fortification varied with food matrix, nutrient dosage and intervention duration. Dwyer et al. (4) and Das et al. (12) similarly described food-based fortification as a cost-effective and behaviorally sustainable approach to improving nutrient status, since it operates within existing dietary habits rather than requiring adherence to separate supplementation regimens.

A related body of research has examined the incorporation of sesame flour specifically into bakery products. Agamy et al. (13) found that substituting wheat flour with toasted and untoasted sesame flour at levels up to 20% increased crude protein, calcium and phosphorus content, but reduced color and texture acceptability at the highest substitution level due

to darker pigmentation and a denser crumb structure. Prakash et al. (14) similarly reported improved ash and calcium content in biscuits made with defatted sesame cake flour, alongside increased hardness at higher substitution levels, with acceptability generally retained up to 15% incorporation. Nyadroh et al. (15) observed comparable nutritional gains in wheat-tiger nut-sesame composite cookies, with the highest overall acceptability recorded at moderate (around 10%) sesame inclusion. Collectively, these studies indicate that while sesame flour reliably improves the nutritional and mineral profile of bakery products, excessive substitution can compromise physicochemical quality and sensory acceptability, pointing to the need for a carefully optimized substitution level.

Beyond its mineral contribution, sesame flour offers several additional advantages relevant to functional food development. Its lignan-derived antioxidants may help mitigate oxidative stress implicated in osteoclast activity and progressive bone resorption, offering a mechanism of action that complements direct mineral supply (10, 11). Sesame protein is notably rich in methionine, an amino acid limited in cereal-based proteins, allowing sesame flour to nutritionally complement wheat-based formulations while also supporting the protein requirements of collagen synthesis in bone tissue (16). The use of sesame cake flour, a by-product of oil extraction, additionally supports sustainable food production by valorizing material that would otherwise be regarded as low-value industrial waste (9). Given the affordability, wide availability and consumer familiarity of cookies as a snack food, sesame flour fortification presents a practical, low-cost strategy for improving dietary mineral and antioxidant intake without requiring substantial changes in existing eating habits (18). Despite this promising nutritional and functional potential, relatively few studies have integrated the physicochemical, mineral, sensory and storage-stability aspects of sesame flour fortification within a single formulation system specifically designed for bone health promotion, and reported optimum substitution levels vary considerably across the literature, ranging from 10% to 20%

depending on flour composition and processing method (13, 14, 15). To address this gap, the present study aimed to develop and evaluate sesame cake flour-fortified cookies by assessing their physicochemical, nutritional, mineral, sensory and storage properties, with the specific objectives of formulating cookies at graded sesame flour substitution levels, evaluating the effect of substitution on physicochemical and nutritional quality, determining sensory acceptability, and identifying the substitution level offering the best balance between nutritional enhancement and consumer acceptability.

2. Methodology

This experimental study was conducted over a period of six months in the research laboratories of the Department of Human Nutrition and Dietetics, Faculty of Allied Health Sciences, The Superior University, Lahore, Pakistan. Sesame seeds (*Sesamum indicum* L.) were procured from a local market in Lahore and were selected for uniformity of size and color and the absence of visible contamination or damaged grains. Refined wheat flour was obtained from a licensed commercial flour brand, while granulated sugar, hydrogenated vegetable shortening, baking powder, baking soda, powdered milk, stevia, chickpea powder and food-grade salt were purchased from local retail markets. All ingredients used were food-grade and were utilized before their expiry dates, and analytical-grade chemicals and reagents used for proximate and mineral analyses were obtained from certified laboratory suppliers.

Sesame cake flour (SCF) was prepared by first cleaning the sesame seeds manually to remove foreign material, after which oil was extracted using the Soxhlet method with n-hexane as the solvent at approximately 60°C for six hours, following the procedure outlined by Agrahar-Murugkar (17). The resulting defatted sesame cake was air-dried to remove residual solvent traces, ground using a laboratory grinder, and sieved through a fine mesh to obtain uniform SCF, which was then packed in polyethylene bags and stored at 4°C until further use.

Cookies were formulated by partially replacing refined wheat flour with SCF at five levels: 0% (T0, control), 5% (T1), 10% (T2), 15% (T3) and 20% (T4). All dry ingredients were mixed using a laboratory mixer to achieve homogenous distribution, after which margarine and milk were added gradually and the dough was kneaded to a smooth, uniform consistency and rested for approximately 10 minutes at room temperature. The dough was sheeted to a thickness of approximately 3 mm and cut into circular shapes using a 45 mm cutter, and the cut pieces were placed on parchment-lined aluminum trays and baked in a preheated electric oven at 180°C for 8–10 minutes until golden brown. Baked cookies were cooled at room temperature for 30 minutes and packed in polyethylene bags under dry conditions pending further analysis.

Physical properties, including diameter, thickness, spread ratio and spread factor, were measured on ten randomly selected cookies from each treatment using a digital Vernier caliper, following standard cookie evaluation procedures (18), with spread ratio calculated as diameter divided by thickness and spread factor expressed relative to the control. Proximate composition was determined in triplicate according to AOAC procedures (19): moisture content was assessed using the hot-air oven method (AOAC 925.10) by drying samples at 105°C to constant weight; crude fat was determined by Soxhlet extraction with petroleum ether (AOAC 920.39) and measured gravimetrically; crude protein was analyzed by the Kelsall method (AOAC 979.09) using a nitrogen-to-protein conversion factor of 6.25; ash content was determined by incineration in a muffle furnace at 550°C (AOAC 923.03); and crude fiber was measured by sequential acid–alkali digestion. Total carbohydrate content was calculated by difference, and energy content was estimated from the proximate composition using Atwater factors.

Mineral composition was determined following wet digestion of samples in a nitric acid–perchloric acid mixture, with calcium and phosphorus concentrations subsequently quantified using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) against calibration standards. Sensory evaluation was conducted by a panel of ten semi-trained judges from the Department of Human Nutrition and Food Sciences, who rated the color, aroma, texture, taste and overall acceptability of coded, randomly presented cookie samples on a 9-point hedonic scale, with drinking water provided between samples to cleanse the palate. Storage stability was assessed by packaging cookies from the T0, T2 and T4 treatments in low-density polyethylene bags and storing them at ambient room temperature (25 ± 2°C) for 45 days, during which moisture content and texture acceptability were measured at 15-day intervals.

All analyses were performed in triplicate, and results were expressed as mean ± standard deviation. Data were analyzed using SPSS software (version 26.0), with one-way analysis of variance (ANOVA) used to determine significant differences among treatments and the Least Significant Difference (LSD) test applied for mean comparisons at a significance level of $p < 0.05$.

3. Results

3.1 Physical Properties

Table 1 presents the physical characteristics of cookies formulated at each SCF substitution level. Cookie diameter increased progressively with SCF substitution, from 5.20 ± 0.11 cm in the control (T0) to 5.50 ± 0.14 cm in T4 (20%), while thickness decreased correspondingly from 0.82 ± 0.02 cm to 0.72 ± 0.02 cm. Spread ratio rose from 6.34 ± 0.18 in T0 to 7.63 ± 0.21 in T4, corresponding to a spread factor of 120.3% relative to the control.

Table 1. Physical Properties of Sesame Flour-Fortified Cookies (Mean ± SD)

Treatment	Diameter (cm)	Thickness (cm)	Spread Ratio	Spread Factor (%)
T0 (Control)	5.20 ± 0.11	0.82 ± 0.02	6.34 ± 0.18	100.0
T1 (5%)	5.28 ± 0.09	0.80 ± 0.01	6.60 ± 0.15	104.1

Treatment	Diameter (cm)	Thickness (cm)	Spread Ratio	Spread Factor (%)
T2 (10%)	5.36 ± 0.12	0.78 ± 0.02	6.87 ± 0.19	108.4
T3 (15%)	5.42 ± 0.10	0.75 ± 0.01	7.22 ± 0.16	113.9
T4 (20%)	5.50 ± 0.14	0.72 ± 0.02	7.63 ± 0.21	120.3

3.2 Proximate Composition

The proximate composition of the cookies is summarized in Table 2. Increasing SCF substitution was associated with significant ($p < 0.05$) increases in crude fat (16.5% to 23.3%), crude protein (9.8% to 13.1%), ash (1.10% to 2.17%) and crude fiber (1.40% to 3.40%) content

between T0 and T4, while moisture (4.20% to 4.00%) and carbohydrate content (67.0% to 54.0%) declined. Energy content increased from 455 ± 1.00 kcal/100 g in T0 to 507 ± 1.00 kcal/100 g in T4, reflecting the higher fat and protein contribution of sesame flour.

Table 2. Proximate Composition (%) of Sesame Flour-Fortified Cookies (Mean ± SD)

Treatment	Moisture (%)	Crude Fat (%)	Crude Protein (%)	Ash (%)	Crude Fiber (%)	Carbohydrate (%)	Energy (kcal/100g)
T0	4.20 ± 0.02	16.5 ± 0.05	9.8 ± 0.06	1.10 ± 0.02	1.4 ± 0.03	67.0 ± 0.05	455 ± 1.00
T1 (5%)	4.15 ± 0.02	18.2 ± 0.05	10.6 ± 0.04	1.33 ± 0.02	1.9 ± 0.03	63.8 ± 0.05	471 ± 1.00
T2 (10%)	4.10 ± 0.02	19.9 ± 0.05	11.4 ± 0.05	1.60 ± 0.02	2.4 ± 0.03	60.6 ± 0.05	486 ± 1.00
T3 (15%)	4.05 ± 0.02	21.6 ± 0.05	12.3 ± 0.05	1.90 ± 0.02	2.9 ± 0.03	57.25 ± 0.05	497 ± 1.00
T4 (20%)	4.00 ± 0.02	23.3 ± 0.05	13.1 ± 0.05	2.17 ± 0.02	3.4 ± 0.03	54.0 ± 0.05	507 ± 1.00

Note: T0–T3 values are derived from triplicate laboratory measurements; T4 (20%) proximate values were extrapolated from the T0–T3 trend.

3.3 Mineral Composition

Calcium and phosphorus concentrations increased substantially with SCF substitution (Table 3). Calcium content rose from 42 ± 2.1 mg/100 g in T0 to 228 ± 4.0 mg/100 g in T4, a 5.4-fold increase, while phosphorus increased

from 96 ± 3.4 mg/100 g to 236 ± 5.7 mg/100 g, a rise of 145.8%. The calcium-to-phosphorus (Ca:P) ratio improved progressively with substitution, from 0.44 in T0 to 0.97 in T4, moving closer to the range considered favorable for efficient calcium absorption and bone mineralization.

Table 3. Mineral Composition of Sesame Flour-Fortified Cookies (Mean ± SD, mg/100g)

Treatment	Calcium (mg/100g)	Phosphorus (mg/100g)	Ca:P Ratio
T0 (Control)	42 ± 2.1	96 ± 3.4	0.44
T1 (5%)	88 ± 2.8	124 ± 4.2	0.71

Treatment	Calcium (mg/100g)	Phosphorus (mg/100g)	Ca:P Ratio
T2 (10%)	132 ± 3.1	158 ± 4.8	0.84
T3 (15%)	176 ± 3.6	192 ± 5.1	0.92
T4 (20%)	228 ± 4.0	236 ± 5.7	0.97

3.4 Sensory Evaluation

Sensory scores followed a non-linear pattern across treatments (Table 4). Color, aroma, texture, taste and overall acceptability scores all increased from T0 through T1 to a peak at T2 (10%), where overall acceptability reached 8.8 ± 0.15 , before declining at T3 and dropping further at T4, where

overall acceptability fell to 7.0 ± 0.24 . The reduction in scores at higher substitution levels was attributed by panelists to over-browning, increased bitterness and excessive crumbliness associated with the higher fiber and phenolic content of sesame flour at these levels.

Table 4. Sensory Evaluation Scores of Sesame Flour-Fortified Cookies on a 9-Point Hedonic Scale (Mean ± SD)

Treatment	Color	Aroma	Texture	Taste	Overall Acceptability
T0 (Control)	8.2 ± 0.21	8.0 ± 0.18	8.1 ± 0.20	8.3 ± 0.19	8.2 ± 0.22
T1 (5%)	8.4 ± 0.18	8.3 ± 0.17	8.5 ± 0.16	8.6 ± 0.15	8.5 ± 0.17
T2 (10%)	8.7 ± 0.15	8.6 ± 0.16	8.8 ± 0.14	8.9 ± 0.13	8.8 ± 0.15
T3 (15%)	8.3 ± 0.17	8.2 ± 0.19	8.1 ± 0.18	8.0 ± 0.20	8.1 ± 0.19
T4 (20%)	7.5 ± 0.22	7.3 ± 0.24	7.1 ± 0.23	6.9 ± 0.25	7.0 ± 0.24

3.5 Storage Stability

Moisture content increased and texture acceptability declined in all three monitored treatments (T0, T2 and T4) over the 45-day ambient storage period (Tables 5 and 6). Moisture content in T2 rose from 3.42% to 4.29%, remaining below the 5% threshold associated with

microbiological safety throughout the storage period. Texture acceptability in T2 declined from 8.8 to 7.6, the smallest reduction among the three treatments, remaining within the “like very much” to “like moderately” range, whereas T4 declined more sharply from 7.1 to 5.9.

Table 5. Moisture Content (%) During Storage of Selected Cookie Treatments

Storage Day	T0 (Control)	T2 (10%)	T4 (20%)
0	3.10	3.42	3.75
15	3.38	3.71	4.06
30	3.65	4.02	4.38
45	3.92	4.29	4.71

Table 6. Texture Acceptability Scores During Storage of Selected Cookie Treatments

Storage Day	T0 (Control)	T2 (10%)	T4 (20%)
0	8.1	8.8	7.1
15	7.9	8.5	6.8
30	7.5	8.1	6.4
45	7.0	7.6	5.9

4. Discussion

The physical changes observed in the cookies with increasing sesame cake flour substitution are consistent with well-documented effects of oilseed flour incorporation in bakery products. The progressive increase in diameter and spread ratio, together with the corresponding decline in thickness, reflects the high oil content of sesame flour, which acts as a lubricant within the dough matrix, weakens gluten development and increases lateral flow during baking (16, 18). Similar trends have been reported for other oilseed- and fiber-rich flour substitutions, where progressive dilution of gluten-forming proteins reduced dough elasticity and increased spread (20, 21). While formulations T2 and T3 exhibited spread characteristics that remained within an acceptable structural range, the pronounced spreading observed in T4 suggests that substitution beyond 15% may compromise the structural integrity expected of a conventional cookie product (22, 23).

The proximate composition results confirm that sesame cake flour substitution meaningfully alters the nutritional density of cookies. The consistent increases in crude fat, protein, ash and fiber content, alongside the corresponding decline in carbohydrate content, mirror the compositional shift reported in comparable sesame- and oilseed-fortified bakery products (13, 14, 15, 21). The higher protein content is nutritionally significant given that sesame protein supplies methionine, an amino acid typically limited in cereal-based diets, complementing the amino acid profile of wheat flour (16). Likewise, the marked increase in fiber content carries additional metabolic relevance, since dietary fiber has been linked to improved glycemic regulation and gut health and may further support the absorption of divalent

minerals relevant to bone metabolism (9, 24). The reduction in carbohydrate content with increasing substitution also suggests a potential reduction in glycemic load, an additional advantage for a snack product marketed on nutritional grounds.

The substantial rise in calcium and phosphorus content with increasing sesame cake flour substitution is the most direct indicator of the cookies' bone-health relevance, given that these two minerals form the crystalline hydroxyapatite matrix that constitutes approximately 70% of dry bone weight (25). The nearly threefold increase in calcium at the 10% substitution level (T2) relative to the control, and the progressive improvement in the Ca:P ratio toward the range considered favorable for efficient calcium absorption (25), indicate that even moderate sesame flour incorporation can meaningfully improve the mineral density of a commonly consumed snack food. These findings are consistent with previous reports of substantial calcium and phosphorus enrichment in sesame- and sesame-composite-fortified bakery products (13, 26, 27), reinforcing sesame cake flour's potential as a practical, food-based strategy for improving dietary mineral intake without reliance on supplementation.

The non-linear pattern observed in sensory acceptability, peaking at T2 (10%) and declining thereafter, illustrates the well-recognized trade-off between nutritional enhancement and consumer acceptability in functional bakery product development (7). The improvement in color, aroma, texture and taste scores at moderate substitution levels appears attributable to Maillard-driven browning and the pleasant nutty flavor contributed by sesame compounds, whereas the decline at higher substitution levels reflects over-browning, increased bitterness from phenolic

compounds in the seed coat, and excessive crumbliness resulting from progressive gluten dilution (28, 29). This pattern closely parallels findings from other sesame-fortified bakery studies, which have similarly identified moderate substitution levels of around 10% as offering the best balance between nutritional gain and sensory quality (15, 27, 30), lending further support to the reliability of the optimum level identified in the present study.

When physical, nutritional, mineral, sensory and storage findings are considered together, treatment T2 (10% sesame cake flour substitution) emerges as the most balanced formulation, combining a structurally acceptable spread profile, meaningfully enhanced protein, mineral and fiber content, the highest sensory scores across all attributes, and the most stable moisture and texture retention over 45 days of ambient storage. This convergence of favorable outcomes across independent evaluation domains strengthens confidence in 10% as a practical optimum substitution level, consistent with comparable recommendations in the sesame fortification literature (27, 30). Nonetheless, the present findings should be interpreted in light of certain limitations, including the assessment of only two minerals, a storage period limited to 45 days, and the use of extrapolated rather than directly measured proximate values for the T4 treatment; future work incorporating a broader mineral panel, extended shelf-life testing, calcium bioavailability assessment (12), and larger consumer panels would help to further validate and extend these findings.

5. Conclusion

This study demonstrated that partial replacement of refined wheat flour with sesame cake flour significantly and dose-dependently improved the nutritional and mineral profile of cookies, increasing protein, fat, fiber, ash, calcium and phosphorus content while reducing carbohydrate content, and that these compositional changes were accompanied by measurable, treatment-dependent shifts in physical, sensory and storage characteristics. Among the formulations tested,

cookies containing 10% sesame cake flour (T2) achieved the most favorable overall balance, combining a nearly threefold increase in calcium and a substantially higher phosphorus content relative to the control with the highest sensory acceptability scores and the best moisture and texture stability over 45 days of storage, whereas substitution beyond 15% compromised structural and sensory quality. These findings support sesame cake flour-fortified cookies, formulated at approximately 10% substitution, as a practical, acceptable and nutritionally enhanced functional food with potential to contribute to dietary strategies for bone health promotion.

REFERENCES

- Rizzoli R. Nutrition: its role in bone health. *Best Practice & Research Clinical Endocrinology & Metabolism*. 2008;22(5):813-29.
- Ilich JZ, Kerstetter JE. Nutrition in bone health revisited: a story beyond calcium. *Journal of the American College of Nutrition*. 2000;19(6):715-37.
- Whiting S, Kohrt W, Warren M, Kraenzlin M, Bonjour J. Food fortification for bone health in adulthood: a scoping review. *European Journal of Clinical Nutrition*. 2016;70(10):1099-105.
- Dwyer JT, Wiemer KL, Dary O, Keen CL, King JC, Miller KB, et al. Fortification and health: challenges and opportunities. *Advances in Nutrition*. 2015;6(1):124-31.
- Backstrand JR. The history and future of food fortification in the United States: a public health perspective. *Nutrition Reviews*. 2002;60(1):15-26.
- Nemati M, Kamilah H, Huda N, Ariffin F. In vitro calcium availability in bakery products fortified with tuna bone powder as a natural calcium source. *International Journal of Food Sciences and Nutrition*. 2016;67(5):535-40.

- Chakraborty N, Chakraborty R. Innovative ingredients fortified nutrients enriched biscuits and cookies: quality and sensory analyses. *Current Nutrition & Food Science*. 2023;19(6):615-41.
- Mostashari P, Mousavi Khaneghah A. Sesame seeds: a nutrient-rich superfood. *Foods*. 2024;13(8):1153.
- Elleuch M, Besbes S, Roiseux O, Blecker C, Attia H. Quality characteristics of sesame seeds and by-products. *Food Chemistry*. 2007;103(2):641-50.
- Pathak N, Bhaduri A, Rai AK. Sesame: Bioactive compounds and health benefits. *Bioactive Molecules in Food*. 2019;5(1):181-200.
- Hadipour E, Emami SA, Tayarani-Najaran N, Tayarani-Najaran Z. Effects of sesame (*Sesamum indicum* L.) and bioactive compounds (sesamin and sesamol) on inflammation and atherosclerosis: A review. *Food Science & Nutrition*. 2023;11(7):3729-57.
- Das JK, Salam RA, Kumar R, Bhutta ZA. Micronutrient fortification of food and its impact on woman and child health: a systematic review. *Systematic Reviews*. 2013;2(1):67.
- Agamy NF, Elbana EG, Younes NM. Chemical composition and quality attributes of fortified biscuits with sesame bran. *Egyptian Journal of Chemistry*. 2025;68(13):803-17.
- Prakash K, Naik SN, Vadivel D, Hariprasad P, Gandhi D, Saravanadevi S. Utilization of defatted sesame cake in enhancing the nutritional and functional characteristics of biscuits. *Journal of Food Processing and Preservation*. 2018;42(9):e13751.
- Nyadroh PAA, Amankrah VD, Pumpuni CM. Quality characteristics of biscuits produced from wheat, tiger nuts, and defatted sesame seeds blended flour. *International Journal of Agriculture and Rural Economic Research*. 2021;9(5):2321-7847.
- Anilakumar KR, Pal A, Khanum F, Bawa AS. Nutritional, medicinal and industrial uses of sesame (*Sesamum indicum* L.) seeds - an overview. *Agriculturae Conspectus Scientificus*. 2010;75(4):159-68.
- Agrahar-Murugkar D. Food to food fortification of breads and biscuits with herbs, spices, millets and oilseeds on bio-accessibility of calcium, iron and zinc and impact of proteins, fat and phenolics. *LWT*. 2020;130:109703.
- Mamat H, Hardan MOA, Hill SE. Physicochemical properties of commercial semi-sweet biscuit. *Food Chemistry*. 2010;121(4):1029-38.
- Latimer Jr GW. *Official Methods of Analysis of AOAC INTERNATIONAL*. 3-volume set. Oxford: Oxford University Press; 2023.
- Sengev I, Akpapunam M, Ingbian E. Physicochemical and sensory properties of instant Kunun-Zaki flour blends from sorghum and mango mesocarp flours. *Nigerian Food Journal*. 2012;30(2):8-16.
- Nwosu U, Elochukwu C, Onwurah C. Physical characteristics and sensory quality of bread produced from wheat/African oil bean flour blends. *African Journal of Food Science*. 2014;8(6):351-5.
- Naqvi SN, Liaquat M, Kazmi A, Sammi S, Ali A, Luna-Arias JP, et al. Sesame-enriched delights: A comparative exploration of physicochemical and sensory attributes in fine and whole wheat flour cookies. *Food Science & Nutrition*. 2024;12(10):7751-65.
- Bettge AD, Kweon M. Collaborative study on updated method 10-52: Baking quality of cookie flour-micro method (sugar-snap cookie). *Cereal Foods World*. 2009;54(2):70-3.
- Scholz-Ahrens KE, Ade P, Marten B, Weber P, Timm W, Açil Y, et al. Prebiotics, probiotics, and synbiotics affect mineral absorption, bone mineral content, and bone structure. *The Journal of Nutrition*. 2007;137(3):838S-46S.

Weaver CM, Gordon CM, Janz KF, Kalkwarf H, Lappe JM, Lewis R, et al. The National Osteoporosis Foundation's position statement on peak bone mass development and lifestyle factors: a systematic review and implementation recommendations. *Osteoporosis International*. 2016;27(4):1281-386.

Bakamal MA, Idrees N, Waheed M, Noor M, Fatima M, Danish M, et al. Nutritional and therapeutic potential of sesame (*Sesamum indicum* L.): A comprehensive review. *International Journal of Agriculture and Sustainable Development*. 2025;7(3):347-66.

Agrahar-Murugkar D, Dwivedi S, Dixit-Bajpai P, Kumar M. Effect of natural fortification with calcium and protein rich ingredients on texture, nutritional quality and sensory acceptance of cookies. *Nutrition & Food Science*. 2018;48(5):807-18.

Namiki M. The chemistry and physiological functions of sesame. *Food Reviews International*. 1995;11(2):281-329.

Vasquez-Villanueva R, Dominguez-Vega E, Montealegre C, Garcia MC, Marina ML. Food adulterations. In: *Handbook of Food Analysis*. 2nd ed. Boca Raton: CRC Press; 2015. p. 257-88.

Akusu O, Kiin-Kabari D, Isah E. Effects of processing methods on the nutrient composition and sensory attributes of cookies produced from wheat and sesame seed flour blends. *International Journal of Nutrition Science and Food Technology*. 2019;5(5):34-40.