Sensory, Vitamin and Microbial Quality of Snack Bar Produced From Sesame Seed (*Sesamum Indicum L*), Peanut (*Arachis Hypogaea*) and Coconut Grits (*Cocos Nucifera)*

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DOI: https://doi.org/10.51584/IJRIAS.2026.11080009

Received: 13 August 2026; Accepted: 18 August 2026; Published: 27 August 2026

ABSTRACT

This study evaluated the sensory, vitamin and microbial quality of snack bars produced from varying proportions of sesame seeds, peanut, and coconut grits. Twelve samples were formulated using mixture design. They were analyzed for their sensory, vitamin and microbiological quality, using standard analytical procedures. Sensory evaluation showed significant ($p<0.05$) differences among the formulations in terms of appearance, aroma, texture, taste, chewiness, and overall acceptability. The sample made from Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0% received the highest scores for all sensory attributes and recorded the highest overall acceptability score (8.80), while the sample containing Sesame 44.5 %: Peanut 25.5%: Coconut Grits 30.0% ranked second in overall acceptability. Vitamin analysis revealed that the snack bars contained appreciable levels of B-complex vitamins. Vitamin B_1 content ranged from 0.41–0.51 mg/100 g, vitamin B_3 from 4.76–6.22 mg/100 g, vitamin B_6 from 0.23–0.28 mg/100 g, vitamin B_9 from 70.55–84.20 µg/100 g, and vitamin B_{12} from 0.025–0.055 µg/100 g. The microbiological quality of the snack bars was assessed based on total viable count, yeast and mould count, and total coliform count. The TVC values ranged from 1.26×10^2 to 1.84×10^2 CFU/g, while yeast and mould counts ranged from 0.54×10^2 to 0.89×10^2 CFU/g. Total coliform counts ranged from 0.14×10^2 to 0.27×10^2 CFU/g. The maximum yeast and mould count (89 CFU/g) recorded was below the 100 CFU/g criterion reported for cereal-bar products. The study concludes that snack bars produced from sesame seeds, peanut, and coconut grits possess appreciable levels of B-complex vitamins, acceptable microbiological safety, and favourable sensory characteristics. The sample made from 50:35:15 of Sesame:Peanut:Coconut Grits demonstrated the best overall performance and is recommended for further studies on shelf-life stability using different packaging materials and storage conditions.

Keywords: Sesame seed, peanut, coconut grits, snack bar, optimization.

INTRODUCTION

The habit of consuming smaller amounts of food and/or drink at short intervals between three standard meals, known as snacking, has become imperative due to reasons like hectic and busy lifestyles, long work hours, etc. (Mattes, 2018). The snack bar is a popular snack prepared by compressing a mixture of cereals, nuts and dried fruits (Momanyi *et al*., 2020). Preparation of snack bar involves the use of a wide range of ingredients in this case sesame seed, peanut and coconut grits. The promotion of sesame-based snacks can contribute to value addition for locally produced sesame seeds, thus supporting agricultural development and enhancing food security.

Sesame (*Sesamum indicum* L.) is one of the world's oldest cultivated oilseed crops and is valued for its exceptional nutritional and functional properties (Kim *et al*., 2025). Sesame is a good source of fiber, protein, unsaturated fatty acids in high proportion, supports digestive health, contains healthy fats, and reduces risks of heart disease, certain cancers, obesity, and type 2 diabetes (McCulloch, 2025). Sesame provides essential micronutrients such as zinc, selenium, copper, iron, vitamin B_6, and vitamin E, which contribute to normal immune function and overall well-being. Sesame seeds are a locally available and nutritionally rich crop that could be leveraged to create value-added snack products (McCulloch, 2025)

Peanuts (*Arachis hypogaea*) are rich in protein, fat, and various healthy nutrients. It is low in carbohydrate and high in protein (Atli Arnarson, 2024). Studies show that they may even be useful for weight loss and are linked to a reduced risk of heart disease (Atli Arnarson, 2024). Nigeria is the leading producer of peanut in Africa and one of the largest producers globally, making the crop an important contributor to food security, household income, employment, and the supply of raw materials for the food processing and edible oil industries peanut has been widely utilized in the development of functional foods and has been associated with benefits such as improved cardiovascular health, better glycemic regulation, and support for healthy body weight (Toomer, 2024).

Coconut (*Cocos nucifera)* is low in carbohydrates and high in fiber and fat, which may be beneficial for blood sugar management (Malaeb & Spoke, 2020). It is an economically important tropical crop cultivated in over 90 countries for its edible endosperm, water, milk, and oil. Global coconut production exceeds 63 million tonnes annually, with Indonesia, the Philippines, and India being the leading producers. In Africa, coconut is widely cultivated in coastal regions, including Nigeria, where it contributes to food security, employment, household income, and provides raw materials for the food, cosmetic, and pharmaceutical industries (FAOSTAT, 2023). These ingredients are selected due to high protein, healthy fats and expected consumer acceptability.

While the demand for alternative healthier snacks continues to rise, the Nigerian snack market remains dominated by products with low nutritional value. This trend contributes to poor dietary patterns and an increased risk of diet-related illnesses among the population (Ayad *et al.*, 2020). However, limited research has been conducted on the systematic development and evaluation of sesame seed-based snacks in Nigeria (Argessa, 2025). Key gaps including understanding the effects of formulation and processing techniques on the physicochemical properties, nutritional quality, and sensory acceptability of such products.

Developing a functional snack bar using sesame seeds, peanut and coconut has the potential to address key nutritional challenges, reduce post-harvest losses, and create value-added products that appeal to health-conscious consumers. This study will contribute to academic knowledge on sesame-based product development, providing data on the sensory characteristics, Vitamin and microbial content of such products. It will also offer practical insights for small- and medium-scale food processors looking to diversify their offerings and promote healthier eating habits among the population. The objective of this study was to develop and evaluate the sensory, Vitamins and microbial properties of sesame seed-peanut-coconut grit snack bar.

MATERIALS AND METHODS

Material procurement

The seeds (sesame, peanuts) and coconut fruit to be used in the study were purchased from Eke Market Ekwulobia, Anambra State, Nigeria.

Production of Toasted Sesame Seed: The method used was described by Animashaun *et al.* (2017). Sesame seeds were cleaned, dehulled by manual abrasion, drained to remove excess water and toasted at 160ºC for 25 minutes, then cooled and stored for further use.

Production of Toasted Peanut: The method used was described by Weissburg *et al.* (2024). Peanut seeds were sorted and dry-cleaned, washed, drained and toasted at 140°C for 15 minutes, then dehulled and winnowed to get dehulled toasted peanuts, which were stored for further use.

Production of Coconut Grits: The method used was described by Pandiselvam *et al.* (2024). The mature coconut endosperm was dehusked and shelled, washed and shredded into smaller sizes, drained and toasted at 120ºC for 10 minutes, then cooled and stored for further use.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue VIII August 2026

Production of Caramel Binder: The method used was described by Chan *et al*. (2025). Granulated sugar was heated on medium heat, which was stirred continuously till caramel syrup was gotten.

Research Design

The Snack bar was produced using mixture design (Simplex Lattice Design) from Design Expert Statistical Software Version 13. The design key is shown in Table 1. The experiment had a total of twelve (12) runs. Some experimental runs had identical mixture proportions as part of the output from the design. These identical runs were independently prepared and analyzed to provide an estimate of experimental variability and to assess the reproducibility of the measured responses. The identical mixture proportions were therefore treated as separate experimental observations. The mixture components, A (Sesame seed), B (peanut), and C (coconut grits), were summed up to 100 as presented in Table 1.

Table 1.0: Experimental Design Key depicting independent variable and their levels

Components (g)		Level of the Factors	
		Low (g)	High (g)
Sesame seed	(A)	35	65
Peanut	(B)	20	35
Coconut Grits	(C)	15	30

A+B+C=100g

Table 2: Design of experiment for Snack bar

Runs	Sample codes	Sesame Seed	Peanut	Coconut Grits
1.	SB1	37.0	35.0	28.0
2.	SB2	50	29.0	21.0
3.	SB3	56.0	28.0	16.0
4.	SB4	44.5	25.5	30.0
5.	SB5	50.0	35.0	15.0
6.	SB6	55.5	20.0	24.5
7.	SB7	63.0	22.0	15.0
8.	SB8	44.0	25.0	30.0
9.	SB9	44.5	25.5	30.0
10.	SB10	63.0	22.0	15.0
11.	SB11	50.0	29.0	21.0
12.	SB12	44.5	25.5	30.0

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue VIII August 2026

NOTE: Runs having identical ingredient proportions represent the experimental points generated by the mixture design. Identical runs were independently prepared and analyzed and were retained for estimation of experimental variability.

SB: Snack Bar

Production of Snack Bar

Sesame seed, peanut and coconut grits snack bar was produced using the process described by Barranco *et al.* (2024) with slight modifications. The response variable runs in Table 2 were mixed and heated on low heat and the binder (caramelized sugar syrup) was added. It was then poured on a flat surface lined with parchment paper. The mixture was pressed into one end and rolled with a wooden rolling pin for uniform thickness (1.5cm). It was allowed to cool for 20 minutes to room temperature (27±2ºC). It was cut with a knife into equal-sized blocks: length (8cm), width (3cm), thickness (1.5cm), weight approximately 40 g and allowed to dry for 30 minutes. The snack bars were wrapped and held for 24 hours before being subjected to analyses.

Fig. 1: Snack bars with different proportions of sesame seeds, peanuts and coconut grits.

Sensory evaluation

The sensory qualities such as Appearance, Aroma, Texture, Taste, Chewiness and Overall acceptability were determined using the 9-point Hedonic scale described by Mihaela (2023). The sensory evaluation of the produced snack bars was performed by 30 Semi-trained Panelists who were trained to assess appearance, aroma, texture, taste, chewiness and overall acceptability using a 9-point hedonic scale before the actual evaluation. The evaluation was conducted using the nine-point hedonic scale ranging from 1 (dislike extremely), 5 (Neither like nor dislike) to 9 (like extremely). The samples were coded with three-digit random numbers allowing them to evaluate and compare the bars' sensory attributes. Questionnaires were made available to the panelists for entering sensory scores. Potable water for mouth rinsing between tastings was made available to the panelists. Each of the samples was rated for appearance, aroma, texture, taste, chewiness and overall acceptability.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue VIII August 2026

Vitamin analysis

Determination of vitamins in the snacks bars

The determination of vitamin (B_1, B_3, B_6, B_9, B_{12}) were carried out using Michael *et al*. (2019). Analytical grade reagents were used throughout. Two grams (2.00 g) of the homogenized snack bar sample were weighed into a conical flask. Twenty-five millilitres (25 mL) of 95% Ethanol was added and the mixture was heated in a water bath for 30 minutes with intermittent shaking. The extract was cooled, and filtered into a volumetric flask. An aliquot of the extract was treated with the appropriate colour-developing reagent for each vitamin and allowed to stand for full colour development. Distilled water was used for preparation of reagents and standards. Stock standards of thiamine hydrochloride (B_1), nicotinic acid/niacin (B_3), pyridoxine hydrochloride (B_6), folic acid (B_9), cyanocobalamin (B_{12}) were prepared and serially diluted to obtain working standards. Blank solutions were prepared using the same reagents without sample extract. The absorbance of the snack bar samples and blank were read at 430 nm for vitamin B1, 450 nm for vitamin B_3, 650 nm for vitamin B_6, and 530 nm for vitamin B_{12} using a UV-visible spectrophotometer (Shimadzu UV-1800). Calibration curves were prepared from standard solutions and sample concentrations were calculated from the calibration equation;

$$B_1\ (\text{mg}/100\ \text{g}) = (C \times V \times D \times 100)/\ (W \times 1000) \quad (1)$$

$$B_3\ (\text{mg}/100\ \text{g}) = (C \times V \times D \times 100)/\ (W \times 1000) \quad (2)$$

$$B_6\ (\text{mg}/100\ \text{g}) = (C \times V \times D \times 100)/\ (W \times 1000) \quad (3)$$

$$B_9\ (\text{mg}/100\ \text{g}) = (C \times V \times D \times 100)/\ (W \times 1000) \quad (4)$$

$$B_{12}\ (\mu\text{g}/100\ \text{g}) = (C \times V \times D \times 100)/\ (W \times 1000) \quad (5)$$

Where:

C = Concentration of vitamin obtained from the calibration curve µg/mL (or mg/L)

V = Final volume of the sample extract (ml)

D = Dilution factor

W = Weight of sample (g)

Microbial evaluation

The Microbiological evaluation was carried out using standard microbiological methods as described by (FSSAI, 2024). Ten (10) grams of each snack bar sample was crushed using a mortar and pestle and aseptically homogenized in 90 ml sterile buffered peptone water to obtain a 10^{-1} dilution, followed by serial ten-fold dilutions which was done by labeling sterile test tubes containing 9 ml of sterile diluent (distilled water, saline, or peptone water) as 10^{-1}, 10^{-2}, 10^{-3}, etc. One (1ml) of the sample was measured and added to the first tube containing 9 ml diluents and mixed thoroughly to obtain the 10^{-1} dilution, using a sterile pipette, 1 ml was transferred from the 10^{-1} tube into the next tube containing 9 ml diluent to obtain the 10^{-2} dilution the process was repeated sequentially to prepare further dilutions (10^{-3}, 10^{-4}, etc.), mixing each tube well before the next transfer. For total viable count, 1ml aliquot of appropriate dilutions was pour-plated in Plate Count Agar and incubated at 35 ± 2°C for 24h. Yeast and mould counts will be determined by plating suitable dilutions on acidified Potato Dextrose Agar and incubating at 28°C for 3 days. Total coliforms were enumerated using Violet Red Bile Agar with incubation at 37°C for 24 h. Plates with 30–300 colonies was counted and results expressed as colony-forming units per gram (CFU/g) of sample. Total viable bacteria count (TVC), total mould count (TMC) and coliform counts (TCC) were estimated by multiplying the means of the total colonies by the dilution factor.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue VIII August 2026

Statistical Analysis

All determinations were carried out in duplicate and the data obtained were subjected to one-way Analysis of Variance (ANOVA) using IBM SPSS version 18 software to determine significant differences at $p<0.05$. Means were separated using Duncan's Multiple Range Test (DMRT).

Ethical Approval

Ethical approval was granted by the Department of Food Science and Technology, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria on 21st April, 2024 (NAU/FST/ETH/2026/04/21/2024836001FN).

Conflict of Interest

The authors declare that there are no conflicts of interest.

RESULTS AND DISCUSSION

Sensory attributes of snack bar

The sensory attributes of the developed snack bar samples were evaluated by 30 semi-trained panelists consisting of regular consumers of snack bars using a 9-point hedonic scale (9= like extremely, 1= dislike extremely). The parameters assessed included appearance, aroma, texture, taste, chewiness, and overall acceptability (Table 3). The sensory scores obtained represented the panelists' sensory acceptability of the products under the conditions of the evaluation. Although the panel provided useful information on the sensory characteristics and relative preference for the snack-bar formulations, a larger consumer-based study involving an appropriately selected target consumer population would be required to establish broader consumer acceptance.

Appearance is often the first quality attribute assessed by consumers and plays a crucial role in determining initial acceptance. The appearance scores ranged from 5.26 to 9.00. The sample containing Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0% (SB5) received the highest appearance score (9.00), indicating that panelists liked its visual characteristics so much

Table 3: Sensory evaluation of snack bar samples

Sample	Appearance	Aroma	Texture	Taste	Chewiness	Overall acceptability
SB1	$8.00^{d}\pm0.00$	$7.63^{d}\pm0.49$	$7.40^{c}\pm0.49$	$7.90^{c}\pm0.54$	$7.56^{b}\pm0.50$	$7.80^{c}\pm0.40$
SB2	$6.00^{h}\pm0.30$	$5.73^{h}\pm0.44$	$5.53^{g}\pm0.50$	$5.90^{g}\pm0.48$	$5.53^{g}\pm0.50$	$5.80^{f}\pm0.40$
SB3	$5.26^{i}\pm0.45$	$5.16^{i}\pm0.40$	$5.10^{h}\pm0.30$	5.26 ± 0.58	$5.26^{g}\pm0.58$	$5.23^{g}\pm0.50$
SB4	$7.00^{f}\pm0.00$	$6.66^{f}\pm0.47$	$6.50^{e}\pm0.50$	$6.76^{e}\pm0.56$	$6.46^{e}\pm0.57$	$6.80^{d}\pm0.40$
SB5	$9.00^{a}\pm0.00$	$8.70^{a}\pm0.46$	$8.53^{a}\pm0.50$	$8.93^{a}\pm0.25$	$8.50^{a}\pm0.50$	$8.80^{a}\pm0.40$
SB6	$8.00^{d}\pm0.00$	$7.86^{c}\pm0.35$	$8.00^{b}\pm0.00$	$8.00^{c}\pm0.00$	$7.70^{b}\pm0.65$	$7.80^{c}\pm0.40$
SB7	$6.50^{g}\pm0.50$	$6.13^{g}\pm0.35$	$6.03^{f}\pm0.30$	$6.40^{f}\pm0.62$	$6.20^{ef}\pm0.48$	$6.16^{e}\pm0.46$
SB8	$8.30^{c}\pm0.50$	$8.00^{c}\pm0.00$	$8.00^{b}\pm0.00$	$8.03^{c}\pm0.40$	$7.66^{b}\pm0.75$	$7.76^{c}\pm0.50$
SB9	$7.00^{f}\pm0.00$	$6.83^{f}\pm0.40$	$6.90^{d}\pm0.30$	$6.63^{e}\pm0.66$	$6.86^{d}\pm0.62$	$6.96^{d}\pm0.41$
SB10	$7.50^{e}\pm0.50$	$7.23^{e}\pm0.43$	$6.90^{d}\pm0.48$	$7.30^{d}\pm0.59$	$7.16^{c}\pm0.37$	$6.96^{d}\pm0.41$

SB11	$6.00^{h}\pm0.00$	$5.83^{h}\pm0.46$	$6.00^{f}\pm0.00$	$6.00^{g}\pm0.52$	$5.93^{f}\pm0.45$	$6.16^{e}\pm0.46$
SB12	$8.56^{b}\pm0.50$	$8.33^{b}\pm0.47$	$8.00^{b}\pm0.00$	$8.50^{b}\pm0.50$	$7.66^{b}\pm0.66$	$8.36^{b}\pm0.49$

Values are the means of two determinations ± standard deviations. Values with different superscripts in the same column are significantly ($p<0.05$) different.

SB: Snack bar

Keys: SB1- Sesame 37.0%: Peanut 35.0%: Coconut Grits 28.0%. SB2 - Sesame 50.0%: Peanut 29.0%: Coconut Grits 21.0%. SB3 - Sesame 56.0%: Peanut 28.0%: Coconut Grits 16.0%. SB4 - Sesame 44.5%: Peanut 25.5%: Coconut Grits 30.0%. SB5 - Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0%. SB6 - Sesame 55.5%: Peanut 20.0%: Coconut Grits 24.5%. SB7 - Sesame 63.0%: Peanut 22.0%: Coconut Grits 15.0%. SB8 - Sesame 44.0%: Peanut 25.0%: Coconut Grits 30.0%. SB9 - Sesame 44.5%: Peanut 25.5%: Coconut Grits 30.0%. SB10 - Sesame 63.0%: Peanut 22.0%: Coconut Grits 15.0%. SB11 - Sesame 50.0%: Peanut 29.0%: Coconut Grits 21.0%. SB12 - Sesame 44.5 %: Peanut 25.5%: Coconut Grits 30.0%.

This was followed by the sample containing Sesame 44.5 %: Peanut 25.5%: Coconut Grits 30.0% (SB12) with a score of 8.56. In contrast, the sample containing Sesame 44.5 %: Peanut 25.5%: Coconut Grits 30.0% (SB9) received a low appearance score of 7.00. The superior appearance score of the sample containing Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0% (SB5) suggests that its colour, surface characteristics, uniformity, and overall presentation were highly attractive to the panelists and higher than the values reported in the development and Quality evaluation of Snack Bars from African breadfruit (*Treculia africana*), Maize (*Zea mays*) and Coconut (*Cocos nucifera*) Blends (Edima-Nyah *et al*., 2019).

Aroma is a critical sensory attribute because it directly influences flavour perception and overall eating experience. The aroma scores varied significantly ($p<0.05$) among the samples, ranging from 5.16 to 8.70. The sample containing Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0% (SB5) received the highest aroma score (8.70), which is higher than the values reported in Development and Quality evaluation of Snack Bars from African breadfruit (*Treculia africana*), Maize (*Zea mays*) and Coconut (*Cocos nucifera*) Blends (Edima-Nyah *et al*., 2019). This indicates a strong preference among the panelists for the aroma and suggests that these formulations produced more pleasant, desirable volatile compounds during processing. The sample containing Sesame 56.0%: Peanut 28.0%: Coconut Grits 16.0% (SB3) got the lowest aroma score (5.16). The roasting and caramelization reactions would have most likely contributed to the development of attractive aroma characteristics that enhanced the panelists' greater preference for the samples with higher values.

Texture is one of the most important quality attributes of snack bars because it influences mouth feel and eating satisfaction. The texture scores ranged from 5.10 to 8.53. the sample containing Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0% (SB5) again recorded the highest score (8.53) which suggests that it possessed a desirable balance between firmness and softness, making it easy and enjoyable to consume and higher compared to the values reported in Development and Quality evaluation of Snack Bars from African breadfruit (*Treculia africana*), Maize (*Zea mays*) and Coconut (*Cocos nucifera*) Blends (Edima-Nyah *et al*., 2019). The lowest texture score (5.10), was observed in SB3 - sample containing Sesame 56.0%: Peanut 28.0%: Coconut Grits 16.0%.

Taste is often regarded as the most influential factor affecting food acceptance because it directly determines consumer satisfaction during consumption. The taste scores for the snack bar samples ranged from 5.26 to 8.93. The sample containing Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0% (SB5) received the highest taste score (8.93. the sample containing Sesame 44.5 %: Peanut 25.5%: Coconut Grits 30.0% (SB9) the sample containing Sesame 56.0%: Peanut 28.0%: Coconut Grits 16.0% (SB3) recorded the lowest taste score (5.26). The exceptional taste score obtained by SB5, being the sample made from Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0%, indicates that its flavour balance was highly preferred by the panelists. The interaction between sweetness, roasted flavours, and ingredient composition may have contributed to its superior taste profile which is higher than the values reported in Development and Quality evaluation of Snack Bars from

African breadfruit (*Treculia africana*), Maize (*Zea mays*) and Coconut (*Cocos nucifera*) Blends (Edima-Nyah *et al*., 2019).

The mean sensory scores for Chewiness ranged from 5.26 to 8.50. Chewiness is an important quality attribute of snack bars because consumers generally prefer products that provide moderate chewing resistance while maintaining a pleasant mouth feel and overall eating experience (Zhang,. *et al* 2024). The sample containing Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0% (SB5) recorded the highest score (8.50), while SB3 (the sample containing Sesame 56.0%: Peanut 28.0%: Coconut Grits 16.0%) obtained the lowest score (5.26). The superior chewiness score of SB5, which was made up of (Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0%), indicates that the product possessed an optimal level of firmness and cohesiveness, making it enjoyable to chew without being excessively hard. In contrast, lower chewiness scores may be associated with products that were either too hard or too soft, resulting in reduced eating satisfaction. These findings suggest that formulation had a substantial effect on the structural properties of the snack bars and subsequently influenced preference among the panelists. The scores were similar to the values reported in Development and Quality evaluation of Snack Bars from African breadfruit (*Treculia africana*), Maize (*Zea mays*) and Coconut (*Cocos nucifera*) Blends (Edima-Nyah *et al*., 2019).

The overall acceptability scores ranged from 5.23 to 8.80. Overall acceptability represents the combined perception of sensory attributes such as appearance, aroma, texture, and taste, and is widely regarded as one of the most important indicators of consumer preference and product acceptance (Danzart *et al.,* 2019). The sample containing Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0% (SB5) received the highest overall acceptability score (8.80), indicating that it was the most preferred formulation among the samples evaluated by panelists. This was followed by SB12 the sample made from (Sesame 44.5 %: Peanut 25.5%: Coconut Grits 30.0%), which scored 8.36. In contrast, the sample Sesame 56.0%: Peanut 28.0%: Coconut Grits 16.0% (SB3) received the lowest overall acceptability score (5.23). The superior overall acceptability of SB5 (Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0%) can be attributed to its consistently high ratings across all sensory parameters, including appearance, aroma, texture, taste, and chewiness. Similarly, the strong performance of SB12 which was made from Sesame 44.5 %: Peanut 25.5%: Coconut Grits 30.0% reflects its balanced sensory characteristics and favourable panelist perception. The scores obtained in this study are higher than the values reported in Development and Quality evaluation of Snack Bars from African breadfruit (*Treculia africana*), Maize (*Zea mays*) and Coconut (*Cocos nucifera*) Blends (Edima-Nyah *et al*., 2019).

Vitamin composition of Snack Bar

The snack bar samples were analyzed for various parameters: vitamin B_1 (thiamine), vitamin B_3 (niacin), vitamin B_6 (pyridoxine), vitamin B_9 (folate), and vitamin B_{12} (cobalamin) (Table 5). The vitamin profile of the developed snack bars (Table 5) provides useful insight into their nutritional value and potential contribution to dietary requirements.

The Vitamin B_1 content ranged from 0.41 to 0.51 mg/100 g, with significant differences observed among the samples. The sample containing Sesame 63.0%: Peanut 22.0%: Coconut Grits 15.0% (SB7) was recorded to have the highest thiamine content (0.51 mg/100g), and the sample containing Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0% (SB5) was recorded as (0.49 mg/100g). Thiamine is an essential water-soluble vitamin involved in carbohydrate metabolism and energy production; it functions as a coenzyme in several biochemical reactions responsible for converting food into usable energy (Mrowicka *et al*., 2023). The thiamine levels observed may be attributed to the naturally occurring B vitamins present in sesame seed and peanut, both recognized as good dietary

Table 5: Vitamin composition of snack bars

S/No	Sample	Vitamin B_1 (mg/100g)	Vitamin B_3 (mg/100g)	Vitamin B_6 (mg/100g)	Vitamin B_9 (µg/100g)	Vitamin B_{12} (µg/100g)
1.	SB1	$0.41^{e}\pm0.01$	$5.78^{b}\pm0.10$	$0.23^{e}\pm0.004$	$75.80^{b}\pm1.30$	$0.025^{e}\pm0.007$

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue VIII August 2026

2.	SB2	$0.47^{c}\pm0.01$	$5.63^{bc}\pm0.09$	$0.26^{c}\pm0.004$	$78.45^{b}\pm1.30$	$0.035^{c}\pm0.007$
3.	SB3	$0.48^{b}\pm0.01$	$5.54^{c}\pm0.09$	$0.27^{bc}\pm0.004$	$78.80^{b}\pm1.40$	$0.030^{de}\pm0.000$
4.	SB4	$0.42^{e}\pm0.01$	$5.13^{d}\pm0.08$	$0.24^{e}\pm0.005$	$71.80^{c}\pm1.30$	$0.045^{ab}\pm0.007$
5.	SB5	$0.49^{b}\pm0.01$	$6.22^{a}\pm0.10$	$0.27^{ab}\pm0.004$	$84.20^{a}\pm1.50$	$0.035^{c}\pm0.007$
6.	SB6	$0.45^{d}\pm0.01$	$4.76^{e}\pm0.08$	$0.25^{d}\pm0.004$	$70.85^{c}\pm1.20$	$0.055^{a}\pm0.007$
7.	SB7	$0.51^{a}\pm0.01$	$5.25^{d}\pm0.09$	$0.28^{a}\pm0.005$	$78.40^{b}\pm1.40$	$0.030^{de}\pm0.000$
8.	SB8	$0.41^{e}\pm0.01$	$5.04^{d}\pm0.08$	$0.23^{e}\pm0.004$	$70.55^{c}\pm1.20$	$0.045^{ab}\pm0.007$
9.	SB9	$0.42^{e}\pm0.01$	$5.10^{d}\pm0.08$	$0.23^{e}\pm0.004$	$71.50^{c}\pm1.20$	$0.050^{ab}\pm0.000$
10.	SB10	$0.50^{ab}\pm0.01$	$5.16^{d}\pm0.09$	$0.27^{ab}\pm0.005$	$77.05^{b}\pm1.30$	$0.035^{c}\pm0.007$
11.	SB11	$0.46^{cd}\pm0.01$	$5.61^{bc}\pm0.09$	$0.26^{c}\pm0.005$	$78.05^{b}\pm1.30$	$0.040^{b}\pm0.000$
12.	SB12	$0.41^{e}\pm0.01$	$5.05^{d}\pm0.08$	$0.23^{e}\pm0.003$	$70.70^{c}\pm1.30$	$0.045^{ab}\pm0.007$

Values are the means of two determinations ± standard deviations. Values with different superscripts in the same column are significantly different ($p<0.05$). SB: Snack bar.

Keys: SB1- Sesame 37.0%: Peanut 35.0%: Coconut Grits 28.0%. SB2 - Sesame 50.0%: Peanut 29.0%: Coconut Grits 21.0%. SB3 - Sesame 56.0%: Peanut 28.0%: Coconut Grits 16.0%. SB4 - Sesame 44.5%: Peanut 25.5%: Coconut Grits 30.0%. SB5 - Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0%. SB6 - Sesame 55.5%: Peanut 20.0%: Coconut Grits 24.5%. SB7 - Sesame 63.0%: Peanut 22.0%: Coconut Grits 15.0%. SB8 - Sesame 44.0%: Peanut 25.0%: Coconut Grits 30.0%. SB9 - Sesame 44.5%: Peanut 25.5%: Coconut Grits 30.0%. SB10 - Sesame 63.0%: Peanut 22.0%: Coconut Grits 15.0%. SB11 - Sesame 50.0%: Peanut 29.0%: Coconut Grits 21.0%. SB12 - Sesame 44.5 %: Peanut 25.5%: Coconut Grits 30.0%.

Sources of thiamine. According to NIH (2024)**,** the Recommended Dietary Allowance (RDA) for Vitamin B_1 (thiamine) is 1.2 mg/day for adult men and 1.1 mg/day for adult women**.** Therefore, the highest-thiamine formulation provides approximately 42.5% and 46.4% of the daily requirement for adult men and women, respectively. Indicating that the developed snack bars may contribute meaningfully to daily vitamin B_1 intake.

The concentration of vitamin B_3 varied significantly among the snack bars and ranged from 4.76 to 6.22 mg/100g. The highest niacin content was recorded in Sample the sample containing Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0% (SB5) as (6.22 mg/100g), while the sample containing Sesame 55.5%: Peanut 20.0%: Coconut Grits 24.5% (SB6) had the lowest value (4.76 mg/100g). The relatively high vitamin B_3 (Niacin) content observed in the developed snack bars may be attributed to the inclusion of peanut and sesame seed, both of which are recognized as good dietary sources of niacin. According to the NIH (2024)**,** the Recommended Dietary Allowance (RDA) for niacin is 16 mg/day for adult men and 14 mg/day for adult women**.** Therefore, the highest-niacin formulation provides approximately 38.9% and 44.4% of the daily vitamin B_3 (Niacin) requirement for adult men and women, respectively. "Vitamin B_3 (Niacin) is important for maintaining healthy skin, supporting digestive function, and promoting proper nervous system activity" (Gasperi *et al.,* 2019). The elevated vitamin B_3 (Niacin) content observed in the sample containing Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0% (SB5) suggests that this formulation possesses enhanced nutritional quality with respect to vitamin B_3.

Vitamin B_6 content of the snack bars analyzed content ranged from 0.23 to 0.28 mg/100g. The sample containing Sesame 63.0%: Peanut 22.0%: Coconut Grits 15.0% (SB7) had the highest concentration (0.28 mg/100g) which indicates that these formulations may provide improved nutritional benefits compared with the other samples, followed by the sample containing Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0% (SB5) having (0.27 mg/100g). The lowest value (0.23 mg/100g) was found in the sample containing Sesame 44.5 %: Peanut 25.5%:

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue VIII August 2026

Coconut Grits 30.0% (SB12). The Recommended Dietary Allowance (RDA) for vitamin B_6 is 1.3 mg/day for healthy adults aged 19–50 years (NIH, 2024). Therefore, the highest-vitamin B_6 formulation provides approximately 21.5% of the daily vitamin B_6 requirement. The observed concentrations suggest that the snack bars can serve as supplementary sources of pyridoxine, which is essential for maintaining normal physiological functions and supporting overall health.

The Vitamin B_9 (Folate) content of the snack bar samples showed significant variation among the snack bar samples, ranging from 70.55 to 84.20 µg/100g. The sample containing Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0% (SB5) recorded the highest Vitamin B_9 (Folate) content of (84.20 µg/100g) which suggests that this formulation may be particularly beneficial from a nutritional standpoint, while the sample containing Sesame 44.5 %: Peanut 25.5%: Coconut Grits 30.0% (SB8) recorded the lowest value (70.55 µg/100g). The Recommended Dietary Allowance (RDA) for folate is 400 µg Dietary Folate Equivalents (DFE) per day for healthy adults NIH (2024). Therefore, the highest-folate formulation (84.2 µg/100 g) provides approximately 21.1% of the recommended daily folate intake. Folate is a critical vitamin involved in DNA synthesis, cell division, and the formation of red blood cells. It is particularly important during periods of rapid growth, such as pregnancy and infancy, due to its role in tissue development and cell replication. Adequate folate intake is also associated with reduced risk of certain forms of anaemia (Fardous & Heydari, 2023). The values obtained across all samples indicate that the developed snack bars can contribute to dietary folate intake and may help improve the micronutrient quality of consumers' diets.

Vitamin B_{12} content of the snack bars ranged from 0.025 to 0.055 µg/100g, with significant differences among the samples. Vitamin B_{12} was recorded the highest in the sample containing Sesame 55.5%: Peanut 20.0%: Coconut Grits 24.5% (SB6) recorded as (0.055 µg/100g), followed by the sample containing Sesame 44.5 %: Peanut 25.5%: Coconut Grits 30.0% (SB9) which was (0.050µg/100g), while the sample containing Sesame 37.0%: Peanut 35.0%: Coconut Grits 28.0% (SB1) had the lowest concentration (0.025 µg/100g. Vitamin B_{12} is essential for red blood cell production, nervous system maintenance, and DNA synthesis. It also plays a role in energy metabolism and cognitive function (Lal & Green, 2024). The Recommended Dietary Allowance (RDA) for vitamin B_{12} is 2.4µg/day for healthy adults. Therefore, the highest-vitamin B_{12} formulation (0.055µg/100 g) provides approximately 2.3% of the recommended daily vitamin B B_{12} intake. The relatively low vitamin B_{12} content observed in all formulations is consistent with the use of plant-based ingredients, as vitamin B_{12} is naturally found predominantly in animal-derived foods and is generally absent from unfortified plant foods (Green *et al*., 2017). The presence of measurable amounts in all formulations is nutritionally significant, the higher concentrations observed in these samples indicate that their formulations may offer additional advantages in supporting blood formation and nervous system health.

The results of the vitamin analysis demonstrates that the developed snack bars contain appreciable amounts of essential B-complex vitamins, which are important for energy metabolism, nervous system function, blood formation, and cellular growth. Considerable variation observed among the formulations, shows that ingredient selection had a significant influence on vitamin content. Among all the samples, the sample containing Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0% (SB5) exhibited the highest levels of vitamin B_3 (6.22 mg/100 g) and vitamin B_9 (84.20 µg/100g), while also maintaining relatively high concentrations of vitamins B_1 and B_6. This suggests that it possesses an excellent vitamin profile. Similarly, the sample containing Sesame 63.0%: Peanut 22.0%: Coconut Grits 15.0% (SB7) recorded the highest levels of vitamin B_1 (0.51 mg/100 g) and vitamin B_6 (0.28 mg/100g), indicating superior potential for supporting energy metabolism and protein utilization. In contrast, the sample containing Sesame 55.5%: Peanut 20.0%: Coconut Grits 24.5% (SB6) recorded the highest vitamin B_{12} concentration (0.055 µg/100g), making it particularly valuable in terms of cobalamin contribution. These results further support the nutritional potential of the developed snack bars as functional foods capable of contributing to improved micronutrient intake and overall dietary quality.

Microbial evaluation of snack bars

The microbiological quality of the developed snack bars was evaluated by determining the Total Viable Count (TVC), Yeast and Mould Count (YMC) and Total Coliform Count (Table 6).

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue VIII August 2026

The Total Viable Count represents the total population of aerobic microorganisms present in a food product and is commonly used as an indicator of overall microbiological quality. In this study, TVC values ranged from 1.26 × 10^2 to 1.84 × 10^2 CFU/g. The sample containing Sesame 37.0%: Peanut 35.0%: Coconut Grits 28.0% (SB1) had the highest total viable count (1.84 × 10^2 CFU/g), the sample containing Sesame 63.0%: Peanut 22.0%: Coconut Grits 15.0% (SB10) exhibited the lowest total viable count (1.26 × 10^2 CFU/g). The differences observed among the samples may be related to variations in ingredient composition, moisture levels, handling practices, and the availability of nutrients that support microbial growth. Samples with lower moisture content generally exhibited lower microbial populations, which are expected because reduced moisture content limits microbial metabolism and reproduction by decreasing water activity, thereby inhibiting microbial growth and contributing to improved microbiological stability and shelf life of food products (Erkmen & Bozoglu, 2016; Syamaladevi *et al*., 2016). The relatively low TVC values suggest that the developed snack bars were produced under hygienic conditions and are unlikely to pose a microbial risk to consumers. The TVC values are within the acceptable limit of 10^4 CFU/g (Saif-ullah *et al*., 2015). Furthermore, the low TVC values suggest that the products possess good keeping quality and may remain stable during storage when packaged and handled appropriately.

Yeasts and moulds are important spoilage organisms that can reduce the shelf life of food products through undesirable changes in flavour, texture, colour, and appearance. Certain mould species may also produce mycotoxins, making their control essential in food products. The yeast and mould counts of the snack bars ranged from 0.54 × 10^2 to 0.89 × 10^2 CFU/g. The sample containing Sesame 37.0%: Peanut 35.0%: Coconut Grits 28.0% (SB1) recorded the highest count (0.89 × 10^2 CFU/g), while the sample containing Sesame 63.0%: Peanut 22.0%: Coconut Grits 15.0% (SB10). Also, the sample containing Sesame 56.0%: Peanut 28.0%: Coconut Grits 16.0% (SB3), showed relatively low yeast and mould populations (0.61 × 10^2 CFU/g), which may be attributed to the reduced moisture content of the snack bars. Overall, the yeast and mould counts obtained in this study are lower than the 10^3 CFU/g safe and permissible level (Saif-ullah *et al*., 2015). The values recorded indicate that the snack bars are microbiologically stable and have a reduced likelihood of spoilage during storage. The values obtained in this study are similar to the values reported in Development and Quality evaluation of Snack Bars from African breadfruit (*Treculia africana*), Maize (*Zea mays*) and Coconut (*Cocos nucifera*) Blends (Edima-Nyah *et al*., 2019).

Coliform bacteria are commonly used as indicators of sanitary quality and possible contamination arising from poor handling practices, contaminated equipment, water, or raw materials. The presence of coliforms does not necessarily indicate the presence of pathogens; however, high coliform counts may suggest inadequate hygiene during processing. The coliform counts obtained for the snack bar samples ranged from 0.14 × 10^2 to 0.27 × 10^2 CFU/g. This range was within the permissible level of 10^2 CFU/g (Saif-ullah *et al*., 2015). The sample containing Sesame 37.0%: Peanut 35.0%: Coconut Grits 28.0% (SB1) had the highest coliform count (0.27 × 10^2 CFU/g), the sample containing Sesame 63.0%: Peanut 22.0%: Coconut Grits 15.0% (SB10) recorded the lowest coliform count (0.14 × 10^2 CFU/g). The low coliform counts observed across all formulations indicate satisfactory hygienic quality during production and handling. From a food safety perspective, the low coliform levels obtained are encouraging and it's an indication that the snack bars were produced under acceptable sanitary conditions.

Table 6 microbial analysis of snack bar

Sample	Total Viable Count (×10^3CFU/g)	Yeast and Mould Count (×10^2 CFU/g)	Total Coliform count (×10^2 CFU/g)
SB1	1.84^a±0.05	0.89^a±0.03	0.27^a±0.02
SB2	1.60^{cd}±0.04	0.73^c±0.02	0.21^{bc}±0.02
SB3	1.40^{fg}±0.04	0.61^{ef}±0.02	0.16^{de}±0.02
SB4	1.74^{ab}±0.05	0.83^b±0.03	0.25^{ab}±0.02

SB5	$1.55^{de}\pm0.05$	$0.70^{cd}\pm0.02$	$0.19^{cd}\pm0.01$
SB6	$1.45^{ef}\pm0.04$	$0.66^{de}\pm0.02$	$0.19^{cd}\pm0.02$
SB7	$1.30^{gh}\pm0.04$	$0.56^{fg}\pm0.02$	$0.15^{de}\pm0.02$
SB8	$1.70^{bc}\pm0.05$	$0.81^{b}\pm0.03$	$0.24^{ab}\pm0.02$
SB9	$1.73^{ab}\pm0.05$	$0.82^{b}\pm0.02$	$0.25^{ab}\pm0.02$
SB10	$1.26^{h}\pm0.03$	$0.54^{g}\pm0.02$	$0.14^{e}\pm0.02$
SB11	$1.58^{d}\pm0.04$	$0.72^{c}\pm0.02$	$0.21^{bc}\pm0.02$
SB12	$1.70^{bc}\pm0.04$	$0.81^{b}\pm0.03$	$0.24^{ab}\pm0.02$

Values are the means of two determinations ± standard deviations. Values with different superscripts in the same column are significantly different ($p<0.05$). SB: Snack bar

Keys: SB1- Sesame 37.0%: Peanut 35.0%: Coconut Grits 28.0%. SB2 - Sesame 50.0%: Peanut 29.0%: Coconut Grits 21.0%. SB3 - Sesame 56.0%: Peanut 28.0%: Coconut Grits 16.0%. SB4 - Sesame 44.5%: Peanut 25.5%: Coconut Grits 30.0%. SB5 - Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0%. SB6 - Sesame 55.5%: Peanut 20.0%: Coconut Grits 24.5%. SB7 - Sesame 63.0%: Peanut 22.0%: Coconut Grits 15.0%. SB8 - Sesame 44.0%: Peanut 25.0%: Coconut Grits 30.0%. SB9 - Sesame 44.5%: Peanut 25.5%: Coconut Grits 30.0%. SB10 - Sesame 63.0%: Peanut 22.0%: Coconut Grits 15.0%. SB11 - Sesame 50.0%: Peanut 29.0%: Coconut Grits 21.0%. SB12 - Sesame 44.5 %: Peanut 25.5%: Coconut Grits 30.0%.

CONCLUSION

The findings of this study showed that snack bars produced from sesame seed, peanut, and coconut grits possessed favourable sensory characteristics, appreciable vitamin content and acceptable microbiological quality. The snack bars contained measurable levels of B-complex vitamins, including vitamins B_1, B_3, B_6, B_9, and B_{12}, indicating their potential contribution to dietary vitamin intake. Snack bars made from 50:35:15 and 63:22:15 of sesame:peanut:coconut grit respectively, demonstrated comparatively superior vitamin profiles, suggesting their potential as nutrient-dense snack products with enhanced B-vitamin contribution. Microbiological analysis revealed low total viable, yeast and mould, and coliform counts across the formulations, indicating satisfactory microbiological quality and safety of the products at the time of analysis. However, the results represent the microbiological status of the products at the time of analysis and do not establish long-term microbiological stability or shelf life. Sensory evaluation showed significant ($p<0.05$) differences among the formulations in appearance, aroma, texture, taste, chewiness, and overall acceptability. Formulating snacks bars with Sesame 50.0%: Peanut 35.0%: Coconut Grits 15.0% (SB5) yields the highest overall acceptability score (8.80). Overall, the results demonstrate that sesame seed, peanut, and coconut grits can be successfully utilized to produce snack bars with appreciable B-complex vitamin content, satisfactory microbiological quality, and good sensory acceptability. The findings suggest that the developed snack bars have potential as nutritious snack products. However, further studies on storage stability, shelf life, packaging performance, consumer acceptance and broader safety assessment are recommended before large-scale commercial production.

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