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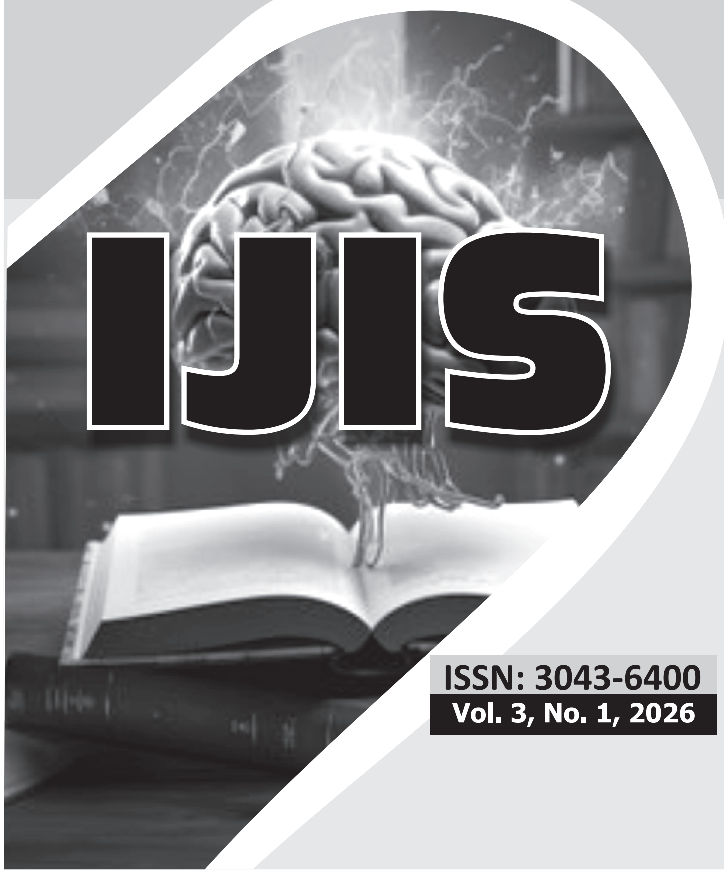

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EVALUATION OF SENSORY AND NUTRITIONAL ATTRIBUTES OF SOYMILK FORTIFIED BREAD

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EVALUATION OF SENSORY AND NUTRITIONAL ATTRIBUTES OF SOYMILK FORTIFIED BREAD

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Abstract

The study evaluated the sensory and nutritional attributes of bread, fortified with varying levels of soymilk, as a strategy to enhance the protein and micronutrient quality of the widely consumed staple food. Bread samples were produced and improved by substituting cow milk with soymilk at 0% (control), 50%, 75%, and 100% levels. Proximate composition, mineral content, antioxidant properties, antinutritional factors, and microbial quality were determined using standard Association of Official Analytical Chemists (AOAC) procedures. Sensory evaluation was conducted using a 9-point hedonic scale with 60 untrained panelists. Data were analyzed using one-way Analysis of Variance (ANOVA) and Duncan's Multiple Range Test (DMRT) at $p < 0.05$.Results showed significant increase at $p < 0.05$ in crude protein (12.3–16.0%), crude fat, ash, crude fiber, and moisture content with increasing soymilk substitution, while carbohydrate content decreased. Mineral analysis revealed significant improvements in calcium, magnesium, iron, zinc, and manganese, with a slight reduction in sodium. Antioxidant components, including β-carotene, total phenolics, flavonoids, vitamins A and C, and total antioxidant activity, increased significantly following fortification. Antinutritional factors such as phytate, tannin, and oxalate decreased after processing, suggesting improved mineral bioavailability. Microbial counts remained within acceptable safety limits, and Escherichia coli(an indicator organism) was not detected in any sample. Sensory evaluation indicated that all bread samples were acceptable, with the 75% soymilk-fortified bread demonstrating *high overall acceptability. The findings indicated that soymilk fortification significantly enhances the nutritional and functional quality of bread without compromising consumer acceptability.*

Keywords: Bread fortification; Soymilk substitution; Sensory evaluation; Proximate composition; Antioxidant activity; Functional foods.

Introduction

Good nutrition is a very important part of human existence and a necessity for survival, physical growth, mental development, performance, and productivity. Nutrition deficiency may sometimes lead to either a recognized disease of unknown etiology or obscure signs and symptoms in an individual (Akhihiero et al., 2022). It has been observed that most food eaten are usually of common nutritional value, mostly composed of carbohydrate. The monotonous consumption of such diet could result in bad nutrition for the individual. As a result, there has been a growing interest in the dietary habits of tertiary institution students in recent years (Ighodalo, 2004). Food fortification involves the deliberate addition of essential nutrients to foods to enhance their nutritional quality and benefit public health (WHO, 2017).

Soybean (Glycine max), which is also referred to as "the protein hope of the future", is a staple food item in diets, a good source of protein and one of the richest and cheapest sources of protein (Asuquo, 2017). In modern times, modifications made on soybeans have led to diverse production of soybeans products i.e., soybean meal serves as a high-protein meat substitute in many food products. Soybean is a good source for weight gain. Compared to protein contents of other foods, the protein content of soybean is about 2 times of other pulses, 4 times of wheat, 6 times of rice grain, 4 times of egg and 12 times of cow milk. One of the most popular legume-based milk products in Nigeria is soymilk (Mbajiuka et al., 2014). The above mentioned qualities of soy make it suitable for biofortification of bread which contain low protein levels and is deficient in essential amino acids such as lysine and threonine (Bakke and Vickers, 2017; Dewettinck et al., 2022; Jideani and Onwubali, 2019).

Soymilk is a nutrient-rich beverage derived from soybeans, offering a valuable source of protein, fiber, and various vitamins and minerals (Atuna et al., 2022). It is a popular alternative to dairy milk, particularly for humans with lactose intolerance or those who prefer vegetarian diets (Boukid et al., 2021). In this part of Africa, bread is a widely consumed food item, especially among students who may have limited time and resources for meal preparation (Obasi et al., 2023). However, traditional bread is often low in protein and other essential nutrients (Idowu-Adebayo et al., 2025; Obasi et al., 2023). Fortifying bread with soymilk or soy-based derivatives can enhance its nutritional profile, particularly by increasing its protein content and potentially improving other aspects of its nutritional value, such as mineral and fiber density (Idowu-Adebayo et al., 2025; Wang et al., 2023).

Bread is an important staple food in both developing and developed countries, serving as a primary source of dietary energy and essential nutrients such as carbohydrates, protein, fiber, vitamins, and minerals (FAO, 2023; Tadesse et al., 2025). The consumption of bread and other wheat-based baked goods, including biscuits, doughnuts, and cakes, is globally ubiquitous due to their convenience and affordability (Gosa andGeleta, 2024). However, a significant concern in its utilization remains the relatively low protein content of refined wheat flour and its deficiency in essential amino acids like lysine and threonine (Mazumder, 2025). This nutritional gap, combined with the loss of bioactive compounds during industrial milling, has intensified the search for fortification strategies to combat "hidden hunger" in wheat-dependent populations (Bouis and Saltzman, 2022; Idowu-Adebayo et al., 2025).

According to Jideani and Onwubali (2019), the enrichment of bread and other cereal based confections with legume flours particularly in regions where protein utilization is inadequate is of great necessity. This is because legumes nutritionally are high in proteins, minerals, vitamins B and lysine (this is an essential but limiting amino acid in most cereals).

The formulation of low-lysine staples supplemented with legumes has been proposed as a practical and sustainable approach to improving the protein nutritional value of foods for young children in developing countries (Atuna et al., 2022; Tadesse et al., 2025). High-protein soy-fortified breads serve as accessible and nutrient-dense sources of nutrition for vulnerable groups, including pregnant and nursing mothers as well as school-aged children (Idowu-Adebayo et al., 2025). Such interventions have been consistently reported to mitigate the incidence of protein-energy malnutrition (PEM) and support healthy growth in resource-constrained settings (Mazumder, 2025; Obasi et al., 2023).

In addition, there is a growing interest in formulating food products containing composite mixtures of malted cereals and legumes as a means of improving the nutritional quality of products suitable for children (Agu and Aluya, 2024). The processing of cereals and legumes (through malting) and the formulation of intermediate products into nutritious mixtures that complement each other, especially in terms of essential amino acids, have been reported by several authors (Alabi and Anounye, 2017). Similarly, the use of legume meal to improve the protein quality of cereal and tuber meal in different food formulations has been studied and reported by various researchers (Agiriga and Iwe, 2018).

Thus, this research seeks to;

I. develop bread samples fortified with soymilk at varying substitution levels of 0% (control), 50%, 75%, and 100% to enhance the nutritional quality of conventional bread;

ii. evaluate the proximate composition (e.g., protein, fat, carbohydrate, moisture, ash, and fiber content), physicochemical properties, and microbiological quality of the soymilk-fortified bread samples; and,

iii. determine the sensory acceptability of the soymilk-fortified bread samples using a 9-point hedonic scale.

Methodology

The study adopted Research and Development Design (R and D) of product research types with focus on developing new products. The experiment was conducted in the laboratory of the Department of

Home Economics, Federal College of Education, Iwo, Osun State, taking care with the hygiene and sanitation of materials, environment and manipulation of the ingredients in all process stages. Raw materials (wheat flour, soybean, refined sugar, fresh yeast, salt, baking powder, egg, butter (fat) and powdered sugar used in the study was procured from local market in Iwo town. Soymilk was prepared in the laboratory. All other necessary ingredients and chemicals used were of analytical grade. Product analysis was done based on the following parameters:

Proximate analysis (protein, carbohydrate, crude fat, crude fiber, ash, moisture contents). Proximate composition of each sample was carried out using methods developed by the Association of Official Analytical Chemists (AOAC, 2010).
Antioxidant properties (flavonoid, β-carotene, total phenolic compounds, total antioxidant activities, vitamin C, vitamin A).
Anti-nutritional factors (phytate, tannins, saponins, oxalates).
Mineral contents (Mg, K, Na, Ca, Fe, Mn, Zn).
Microbiological properties (total fungal and bacterial counts, *E.coli*).
Determination of Colour Properties: CIE L*a*b colorimeter analysis was carried out to determine the colour properties.

Product Development:

Preparation of soymilk:The soybean was steeped and parboiled, the parboiled soybean was processed into a soymilk beverage using the traditional method as described by Momoh et al., (2021). The steeped parboiled soybean was rinsed and agitated in portable water to separate the hulls and then wet milled into slurry using a disc mill. The slurry was mixed with 5 portions of its weight in portable water and then filtered through a double folded muslin cloth to obtain the milky extract. The milky extract will then be pasteurized at 72°C for 15 min with constant stirring. The pasteurized soy milk was allowed to cool at room temperature, packaged, labelled and refrigerated for further analysis.

Bread production: Bread was prepared according to **Chauhan et al., (1992)**with replacement ofthe cow milk by soymilk in bread doughs (B0, B1, B2, and B3). The percentage of soymilk was 0%, 50%, 75%, and 100%. The bread dough was prepared by mixing the ingredients in a mechanical dough mixer. Tap water and corn oil would be added to the dry ingredients. All ingredients would bemixed again for 10 min. The dough was fermented for 90 min and baked in rectangular tefal tray (28cm x 12cm x 6cm) (L x W x H) at 260°C for 30 min in an electric oven. After baking, bread was left to cool on a cooling rack and cut with a sharp knife into ~1.5 cm slices. Soymilk fortified bread will then be packed in polyethylene bags and stored for 12 h (overnight) in a dry place before sensory testing begin. All determination and sensory testing would be conducted the following day.

Instrumentation

The instrument that was used for collection of data is Evaluation of Sensory and Nutritional Attributes of Soymilk-Fortified Bread (ESNASFB) Score Card, which was adapted for this study. A 9-point hedonic scale was used, rated as; 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much, 9 = like extremely. In order to determine the validity of the instrument, **it was** validated by three (3) experts in the field of Home Economics. Reliability of the instrument was determined through pilot test.

Twenty respondents comprising of students were used to carry out the pilot test in which the sample was coded and presented to the respondents. The samples were served in white cups at room temperature for the assessment of aroma, colour, taste, mouth-feel and overall acceptability. The white cups would reveal the samples for clear judgment of the panelists. The consumers were assessed based on their responses mostly to non-verbal cues such as body movements, vocalizations and facial expressions. Data was collected from the respondents during the assessment sessions. Untrained panelists was selected and included in the sensory evaluation based on pre-determined inclusion criteria. The sensory qualities in terms of colour, taste, appearance, flavour, texture, and overall acceptability of the soymilk-enriched bread was evaluated by a 60-

man consumer-based panel.

The samples were served in white cups at room temperature for the assessment of aroma, colour, taste, mouth-feel and overall acceptability. The white cups revealed the samples for clear judgment of the panelists. The consumers were assessed based on their responses mostly to non-verbal cues such as body movements, vocalizations and facial expressions. Data was collected from the respondents during the assessment sessions. Evaluation session was conducted in Federal College of Education, Iwo, Osun State using the previously described 9-point hedonic scale. The data obtained was statistically analyzed by the analysis of variance (ANOVA) using SPSS 20.0 for Windows and the Duncan Multiple range test with significance level at $p < 0.05$ (Ihekoronye and Ngoddy, 1985).

Results and Discussion

Recipe Formulation for Bread Production

With respect to the objectives of the study, recipes supplemented with varying levels of soy milk were formulated for bread production. As shown in Table 1 below, dry and wet ingredient such as; wheat flour, sugar, salt, raising agents (yeast and baking powder), butter, eggs, vinegar, milk and of course water, were ingredients mixed in appropriate proportions as required by the recipe developed by the researcher. All ingredients were measured in grams/ml accordingly.

Also, the treatment plan used for the preparation of various bread samples is stated as follows; Sample A/T_1 (Cow milk 100%/Soymilk 0%), Sample B/T_2 (Cow milk 50%/Soymilk 50%), Sample C/T_3 (Cow milk 25%/Soymilk 75%) and Sample D/T_4 (Cow milk 0%/Soymilk 100%).

Table 1: Formulation of Regular and Soymilk Composite Doughs

Ingredients (%)	**Sample A**	**Sample B**	**Sample C**	**Sample D**
Whole-wheat flour (g)	400	400	400	400
Sugar (g)	75	75	75	75
Salt (g)	3	3	3	3

Ingredients (%)	**Sample A**	**Sample B**	**Sample C**	**Sample D**
Yeast/Baking Powder(g)	12/7	12/7	12/7	12/7
Fat/Butter (g)	50	50	50	50
Eggs (g)	50	50	50	50
Vinegar (ml)	8	8	8	8
Regular milk (ml)	64	32	16	0
Soymilk (ml)	0	32	48	64
Water (ml)	250	250	250	250
Total dough weight (g)	650	650	650	650

Proximate Composition of Soymilk-Fortified Bread Samples

The proximate composition of the bread samples were determined as presented in Table 2. Moisture, crude protein, fat, ash, and crude fiber increased progressively with higher soymilk substitution, while carbohydrate content decreased.

Table 2: Proximate Composition of Bread Samples Fortified with Soymilk

Sample	**Moisture (%)**	**Crude Protein (%)**	**Crude Fat (%)**	**Ash (%)**	**Crude Fiber (%)**	**Carbohydrate (%)**
A (0%)	30.6	12.3	2.6	1.7	1.8	51.0
B (50%)	35.4	14.6	2.8	2.4	2.2	42.5
C (75%)	36.5	15.2	3.2	2.6	2.4	40.1
D (100%)	38.1	16.0	3.6	3.0	2.5	36.8

The significant increase($p < 0.05$) in protein content across the samples reflects the high-quality protein contribution from soymilk, a legume-based ingredient known for its rich amino acid profile. This observation agrees with findings by Oluwamukomi and Adeyemi (2018), who reported similar improvements in protein content of wheat-soy composite bread. The increase in crude fat and ash content is attributable to the inherent lipid and mineral composition of soybeans, as similarly reported by Adeyeye et al., (2020).

Conversely, the reduction in carbohydrate content with increasing soymilk substitution can be attributed to the dilution of starchy wheat flour components, as soymilk solids replace part of the flour. The higher moisture content observed in fortified samples suggests increased water-binding capacity due to the presence of soy protein and fiber, which enhance the dough's water retention and implies that, while this may improve softness, it could reduce shelf life if not properly stored.

Mineral Composition

The mineral content of the bread samples showed significant ($p < 0.05$) increases in magnesium, calcium, iron, manganese, and zinc with rising soymilk levels, except for sodium which decreased slightly. This trend underscores the mineral-rich nature of soymilk and supports previous reports by Olatunji et al., (2017), who observed enhanced mineral fortification in soy-based baked goods.

High calcium and magnesium levels are essential for bone formation and enzyme activation, while iron and zinc contribute to hemoglobin synthesis and immune function, respectively (WHO, 2019). The decline in sodium concentration with higher fortification may be advantageous for cardiovascular health, making the bread a healthier alternative for consumers seeking low-sodium diets.

Table 3: Mineral Composition (mg/100g) of Soymilk-Fortified Bread

Sample	Mg	K	Na	Ca	Fe	Mn	Zn
A (0%)	22.5	184.5	61.3	27.1	1.42	0.24	1.94
B (50%)	25.9	194.3	60.1	34.7	1.40	0.29	2.15
C (75%)	29.2	198.3	58.4	41.2	1.58	0.35	2.36
D (100%)	32.7	198.7	56.4	47.7	1.59	0.40	2.61

Antinutrient Composition

Phytate, tannin, and oxalate contents decreased significantly ($p < 0.05$) with increasing soymilk substitution, indicating that baking and heat processing reduced these antinutritional compounds. Similar trends have been reported by Omueti et al., (2015), who found that thermal treatment and enzymatic activity in dough significantly degrade phytate and tannin.

The reduction in antinutrients enhances the bioavailability of essential minerals like calcium and iron, as these compounds otherwise chelate with minerals and impedes absorption. Saponin levels showed slight fluctuation but remained within safe limits, consistent with previous findings by Nsofor et al., (2020), which established that soy-based bakery products contain low, non-toxic saponin concentrations.

Table 4: Antinutrient Levels (mg/100g) in Soymilk-Fortified Bread

Sample	Phytate	Oxalate	Saponin	Tannin
A (0%)	21.4	2.58	3.03	5.90
B (50%)	17.0	2.47	3.76	5.54
C (75%)	13.3	2.52	3.38	5.29
D (100%)	12.9	2.29	3.42	5.04

Antioxidant Properties

A progressive and significant increase ($p < 0.05$) was observed in β-carotene, total phenolic content, flavonoids, total antioxidant activity, and vitamins A and C with soymilk fortification. This confirms the contribution of soymilk's polyphenolic compounds and carotenoids to the antioxidant potential of the bread.

The enhancement of antioxidant properties is nutritionally beneficial, as these compounds protect the body from oxidative stress and reduce the risk of chronic diseases such as cancer and cardiovascular disorders (Oboh et al., 2014). This observation aligns with the findings of Olagunju et al., (2021), who reported that incorporation of legume-based ingredients in baked goods increased antioxidant content and functional quality.

Table 5: Antioxidant Composition of Soymilk-Fortified Bread

Sample	β-Carotene (µg/g)	Total Phenolics (mg/100g)	Flavonoids (mg/100g)	Total Antioxidant (%)	Vitamin C (mg/100g)	Vitamin A (µg/100g)
A (0%)	0.65	30.1	19.7	20.1	14.1	21.4
B (50%)	0.87	39.0	26.9	46.5	17.3	38.8
C (75%)	1.24	54.1	34.6	60.1	20.4	46.8
D (100%)	1.61	58.7	37.4	65.9	23.5	50.4

Microbial Quality

The microbial count of all samples fell within acceptable limits for baked products (cfu $\leq 1.0\times10^5$/g), indicating good hygienic handling and adequate baking temperatures (ICMSF, 2011). The absence of E. coli(the common indicator organism) further confirms the microbiological safety of the bread. Although a slight increase in microbial count was observed with higher fortification levels, this may be linked to increased moisture content, which can favor microbial growth if storage conditions are suboptimal.

Table 6: Microbial Load of Bread Samples

Sample	Total Bacteria (cfu/g)	Total Fungi (cfu/g)	*E. coli*
A	$4.0\times10^3 – 5.0\times10^3$	$1.0\times10^3 – 2.0\times10^3$	Not detected
B	$5.0\times10^3 – 6.0\times10^3$	$2.0\times10^3 – 2.0\times10^3$	Not detected
C	$5.0\times10^3 – 3.0\times10^3$	$3.0\times10^3 – 2.0\times10^3$	Not detected
D	$7.0\times10^3 – 8.0\times10^3$	$3.0\times10^3 – 4.0\times10^3$	Not detected

Overall Nutritional Implication

The composite analysis demonstrates that soymilk fortification substantially improves the nutritional, functional, and safety profile of bread. The increase in protein, mineral, and antioxidant content underscores its potential as a functional meal with enhanced health benefits. These findings are consistent with previous works (Adebayo andAdedeji, 2020; Oluwamukomi et al., 2018) advocating the use of legume-based fortification to combat protein-energy malnutrition and micronutrient deficiencies.

Sensory Attributes of Soy Milk Fortified Bread

Mean values showing score for sensory attributes are presented in Table 7. Sample A showed highest mean score for appearance (7.83) followed by Sample D (7.37), Sample B (7.20) and Sample C (6.98). The crust color appears lighter as quantity of soymilk increases across bread samples. Supplementation of soymilk in bread and crumb color had positive correlation with each other. The highest score obtained by the treatments for aroma was Sample D (7.45) followed by 7.33, 6.92 and 6.37 for Sample A, Sample C and Sample B respectively.

The baking conditions, state of the flour components, such as starch, fibres, protein (gluten) and the amount of water absorbed during dough mixing, all are responsible for the final texture of the breads (Gomez et al.,2023). The highest score obtained by the treatments for Texture was Sample D (8.28) followed by 7.33, 7.20 and 7.15 for Sample A, Sample B and Sample C respectively.

Sample C showed mean score 7.42 followed by 7.10, 7.03 and 6.90 for Sample D, Sample A and Sample B for the taste of bread, respectively. The addition of soymilk slightly affected the taste of bread, although panelists did not really note much difference between the taste of the soymilk-enriched bread and the composite breads. Serremet al.,(2021) resulted that substitutions of soya bean flour into wheat bread were associated with beany taste, aroma and after taste.

Overall Acceptability

For overall acceptability, all the treatments were assigned above average scores so all the treatments were acceptable. However, 0% soymilk bread was assigned highest scores(8.10) and 100% soymilk bread got (7.75). 75% Sample C (7.58) and 50% Sample B (7.52) were non-significant to each other but significantly different from Sample A and Sample D.

Table 7: Sensory Mean Scores of Regular and Soymilk Enriched Bread

Bread Samples	Appearance	Aroma	Texture	Taste	Overall Acceptability
A	7.83	7.33	7.33	7.03	8.10
B	7.20	6.37	7.20	6.90	7.52
C	6.98	6.92	7.15	7.42	7.58
D	7.37	7.45	8.28	7.10	7.75

Source: Field Survey, 2025 *SPSS v20*

Consumer Acceptability of Bread Enriched With Soymilk

The responses of the respondents on the consumer acceptability of bread enriched with soymilk (Table 8). According to the responses of the respondents, it was revealed that the item stating the texture of the bread is acceptable has the highest mean (4.33) and closely followed by the item asking about the conviction of how nutritious soymilk-fortified bread is (4.32). Next is "I enjoy the taste of soymilk-fortified bread", "I would recommend this bread to others", "the appearance of the bread is attractive", "I am willing to eat soymilk-fortified bread regularly", "I find the aroma of the bread appealing" and lastly, "I prefer this bread to regular bread without soymilk", which have mean scores of 4.28, 4.12, 4.03, 3.87, 3.85 and 3.67.

From these responses, it can be inferred that consumers are open-minded to accepting soymilk-fortified products. This was not in correlation with the testament of Rita and Sophia (2010), whose organoleptic analysis indicated that generally, whole bread and soy-supplemented bread with soybean flour below 30% is preferred to bread with soybean flour beyond 30%. Also, the preference of the wheat flour bread may be due to the familiarization of consumers to the normal whole wheat flour.

Table 8:Mean Rating of Consumer Acceptability of Bread Enriched with Soymilk

N=60

Consumer Acceptability and Preference	**Strongly Agree %**	**Agree %**	**Neutral %**	**Disagree %**	**Strongly Disagree %**	**Mean**	**SD**
I enjoy the taste of soymilk-fortified bread.	23(38.3)	33 (55.0)	3 (5.0)	0 (0.0)	1 (1.7)	4.28	0.72
The texture of the bread is acceptable.	27 (45.0)	26 (43.3)	7 (11.7)	0 (0.0)	0 (0.0)	4.33	0.68
I find the aroma of the bread appealing.	11 (18.3)	32 (53.3)	14 (23.3)	3 (5.0)	0 (0.0)	3.85	0.78
The appearance of the bread is attractive.	20 (33.3)	29 (48.3)	6 (10.0)	3 (5.0)	2 (3.3)	4.03	0.97
I believe soymilk-fortified bread is nutritious.	28 (46.7)	25 (41.7)	6 (10.0)	0 (0.0)	1 (1.7)	4.32	0.79

Consumer Acceptability and Preference	Strongly Agree %	Agree %	Neutral %	Disagree %	Strongly Disagree %	Mean	N=60 SD
I am willing to eat SF Bread regularly.	14 (23.3)	27 (45.0)	16 (26.7)	3 (5.0)	0 (0.0)	3.87	0.83
I would recommend this bread to others.	11 (18.3)	29 (48.3)	11 (18.3)	7 (11.7)	2 (3.3)	4.12	0.83
I prefer this bread to regular bread without soymilk.	11 (18.3)	29 (48.3)	11 (18.3)	7 (11.7)	2 (3.3)	3.67	1.02

Key: N –Number of respondents, SD – Standard deviation
Source: Field Survey, 2025 SPSSv20

Pearson Product Moment Correlation on the Relationship between the Sensory Attributes and Level of Consumer Acceptability of Bread Enriched with Soymilk

Test of Hypotheses

H_o1: There is no significant relationship between the sensory attributes and level of consumer acceptability of bread enriched with soymilk

The Pearson Product Moment Correlation showing the relationship between sensory attributes and level of consumer acceptability of bread enriched with soymilk (Table 9). However, the null hypothesis that states that there is no significant relationship between the sensory attributes and level of consumer acceptability of bread enriched with soymilk was tested at significance level of 0.005. From the table, the *R-value* was 0.748*,* and *P-value* was 0.000, hence, the null hypothesis was rejected since the p-value is less than 0.005. Therefore, there is a significant relationship between the sensory attributes and level of consumer acceptability of bread enriched with soymilk.

Table 9: Pearson Product Moment Correlation on the Relationship between the Sensory Attributes and Level of Consumer Acceptability of Bread Enriched with Soymilk

Variables	N	Mean	Std. Deviation	R	Sig- p (2tailed)	Decision
Sensory Attributes	60	30.95	2.94	0.748	0.000	Significant
Consumer Acceptability	60	63.42	4.85			

Source: Field Survey, 2025

Conclusion

This study demonstrates that soymilk fortification significantly improves the nutritional and functional quality of bread while maintaining acceptable sensory characteristics. Increasing substitution levels resulted in higher protein, mineral, fiber, and antioxidant contents, alongside a reduction in carbohydrate concentration and antinutritional factors. These findings confirm the effectiveness of incorporating legume-based ingredients into cereal products to enhance amino acid balance and micronutrient density.

The reduction in phytate, tannin, and oxalate suggests improved mineral bioavailability, while the elevated antioxidant profile indicates added functional benefits beyond basic nutrition. Microbiological analysis further established that all bread samples met acceptable safety standards, with no detection of indicator organisms.

Although the control sample recorded slightly higher overall acceptability, the 75% soymilk-fortified bread recorded strong sensory ratings and represents an optimal balance between nutritional enhancement and consumer preference. Overall, soymilk-fortified bread offers a practical, cost-effective strategy for improving dietary protein and micronutrient intake among young adults and students.

Further studies on shelf-life stability, amino acid profiling, and large-scale consumer evaluation are recommended to support commercial scalability and broader public health application.

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