Microbiological Quality of Bread Incorporated with Selected Bread Improvers

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ABSTRACT

Bread is widely consumed as a staple food, but its high moisture and nutrient content make it susceptible to microbial contamination and spoilage. This study evaluated the microbiological properties of bread incorporated with selected bread improvers. In order to determine the influence of these improvers on microbial quality and shelf life, which revealed that the bread which contains STK had the highest freshness value of 73% at 11.75% crumb moisture? The bread containing ascorbic acid had lower bacteria counts (2.47×10^2 – 2.87×10^2 cfu/g) than the other bread samples. Standard baking procedures were used to produce bread samples containing different bread improvers, while a control sample without improvers was also prepared. Microbiological analyses were carried out using standard plate count techniques to determine the total viable bacterial count, coliform count, and fungal count during storage. The results revealed variations in microbial load among the different bread samples. Bread incorporated with selected bread improvers showed relatively lower microbial counts compared with the control, indicating improved microbial stability and extended shelf life. The predominant microorganisms isolated included species of *Bacillus, Staphylococcus, Aspergillus, and Penicillium*, which are commonly associated with bakery products. The presence of microorganisms can be attributed to environmental contamination, improper handling practices, and inadequate storage conditions. However, the microbial counts recorded remained within acceptable food safety limits during the early storage period. The findings suggest that the incorporation of appropriate bread improvers can enhance not only the physical quality of bread but also its microbiological safety and storage stability. Therefore, the use of suitable bread improvers in bread production is recommended as a strategy to improve shelf life and maintain the microbiological quality of bakery products; hence, the bread, containing the improvers had significantly ($p<0.05$) lower moulds and total viable count of 41.67-49.67 and 41.0- 59.33, respectively. For each of the storage periods, the mould count and total viable counts for the improvers were in the decreasing order guar gum < ascorbic acid < Panok < STK.

KEYWORDS

Bread improvers, Microbiological quality, Shelf life, fungal contamination, Bacterial load, Bakery products

I. INTRODUCTION

Bread is a staple fermented food produced through the transformation of wheat flour, water, yeast, and salt into a structured product via mixing, fermentation, shaping, proofing, and baking processes. In Nigeria, bread consumption has grown significantly; making it one of the most commonly consumed non-indigenous foods, second only to rice. Its widespread acceptance is largely due to its affordability, ease of consumption, sensory appeal, and nutritional contribution to the daily diet. Bread provides a substantial amount of energy from carbohydrates, alongside proteins, lipids, and essential micro-nutrients required for maintaining human health. Despite its importance, local wheat production in Nigeria remains insufficient to meet industrial demand. Consequently, the baking industry depends heavily on imported wheat flour, resulting in continuous pressure on foreign exchange reserves. In response, research efforts have focused on the partial substitution of wheat with flours obtained from indigenous crops. This approach aims not only to reduce import dependency but also to improve the nutritional profile of bread products.

One such intervention is the incorporation of cassava flour at a substitution level of about 10%, which has been promoted as a strategy to enhance food security and reduce production costs. However, the utilization of composite flours introduces several processing and quality limitations. The absence of gluten-forming proteins in non-wheat flours significantly affects dough viscoelasticity, thereby impairing gas retention during fermentation. As a result, the dough becomes less extensible and more difficult to process, leading to reduced loaf volume and inferior crumb characteristics. In addition, composite bread formulations tend to exhibit accelerated stalling due to increased starch retro gradation, which negatively impacts shelf life and consumer acceptability. The superior baking performance of wheat flour is primarily linked to gluten, which forms a cohesive and elastic network capable of entrapping carbon dioxide produced during fermentation, ultimately yielding bread with desirable texture and structure. The shelf stability of bread is largely governed by two major factors: physicochemical changes associated with stalling and microbial deterioration. Staling of bread leads to crumb firming and loss of freshness, while microbial spoilage results in visible and non-visible contamination that compromises safety and quality. Among spoilage organisms, moulds are the predominant contaminants in bread, contributing to both economic losses and potential health hazards through the production of toxic secondary metabolites.

To mitigate quality defects and extend shelf life, the baking industry employs various bread improvers, which function as dough conditioners. Additives such as ascorbic acid and hydrocolloids enhance dough strength, improve gas retention, and increase loaf volume. Furthermore, these improvers contribute to delaying staling by regulating moisture migration within the bread matrix, thereby preserving crumb softness and overall product quality. Water activity (aw) is a critical determinant of microbial growth in bakery products. Although freshly baked bread generally possesses moisture levels that restrict the proliferation of most microorganisms, it remains highly susceptible to fungal contamination. Post-baking contamination, often arising from airborne spores or contact with contaminated equipment, is the primary route of spoilage. Common fungal genera associated with bread spoilage include *Rhizopus*, *Mucor*, *Penicillium*, *Aspergillus*, and *Eurotium*, with *Rhizopus stolonifer* being one of the most frequently encountered species. Environmental factors, particularly humidity, play a crucial role in the progression of fungal spoilage. Lower

humidity conditions tend to suppress mould development, whereas higher moisture levels promote rapid colonization. In addition to visible spoilage, certain fungal species are capable of producing mycotoxins, which present significant health risks to consumers. It has been reported that spoilage-related losses in bakery products may range from 1% to 5%, depending on storage and processing conditions. Yeasts also contribute to bread spoilage, although less frequently than moulds. Their presence is typically associated with post-processing contamination from bakery equipment such as slicers and conveyors. Yeast growth is often characterized by the appearance of whitish or creamy patches on bread surfaces, with species such as Pichia implicated in this form of deterioration. Another significant spoilage phenomenon in bread is rope formation, which is primarily caused by spore-forming bacteria, particularly Bacillus subtilis. This defect is characterized by a sticky crumb texture, discoloration, and the emission of a fruity or unpleasant odor. The degradation of bread structure during rope spoilage is attributed to enzymatic activities, including proteolysis and amylolysis, carried out by bacterial enzymes.

The spores responsible for this spoilage are commonly introduced through raw materials such as flour and are capable of surviving baking temperatures due to their heat resistance. Although stringent hygiene practices and the use of preservatives have reduced the incidence of rope spoilage in developed countries, the increasing preference for preservative-free products may elevate the risk of contamination. Additionally, warm climatic conditions favour bacterial growth, thereby increasing the likelihood of spoilage in tropical environments. In light of these challenges, there is a need to evaluate strategies that can enhance the microbiological safety and shelf stability of bread. Therefore, this study investigates the microbiological characteristics of bread produced with selected bread improvers, with a focus on improving quality, extending shelf life, and ensuring consumer safety.

II. MATERIALS AND METHODS

A. Sources of materials

All ingredients used for this study, including commercial wheat flour (Valeubra brand), granulated sugar, iodized salt, baker's yeast, and bread improvers (ascorbic acid, guar gum, Panok®, and STK Royal), are obtained from Gboko Main Market located in Gboko Township, Benue State, Nigeria. Before use, the materials were preserved under refrigeration at approximately 10°C to maintain their quality.

B. Preparation of breads

Bread samples were produced using a modified method based on Akubor and Obiegbuna (2014). The formulation is detailed in Table 1. The ingredients included wheat flour (59.10 g), sugar (10.31 g), salt (0.80 g), shortening (0.59 g), water (33.6 mL), yeast (1.42 g), and calcium propionate (0.25 g).

All dry components were initially blended using the rubbing-in technique to ensure uniform distribution. Yeast was activated separately by dissolving it in a measured quantity of water. A depression was formed at the center of the flour mixture, and the activated yeast solution was introduced and mixed thoroughly. The mixture was covered with clean cheesecloth and allowed to ferment for approximately 1 hour and

30 minutes. After fermentation, the remaining water was incorporated, and the dough was kneaded manually until a smooth, non-sticky consistency was achieved. The dough was then proofed, shaped, and carefully transferred into greased baking pans. Baking was carried out in an oven at 220°C for 10 minutes. Upon completion of baking, the loaves were allowed to cool at room temperature before being packaged in polyethylene bags. The samples were stored under laboratory conditions until further analysis. Bread prepared without the addition of improvers served as the control sample. A schematic representation of the bread-making process is provided in Figure 1.

Table 1: Recipe for the preparation of bread formulation

Ingredients	**Guar gum**	**Ascorbic acid**	**Panok^{R}**	**D-STK Royal**	**Control**
Wheat flour(g)	59.10	59.10	59.10	59.10	59.10
Yeast	1.42	1.42	1.42	1.42	1.42
Sugar	4.31	4.31	4.31	4.31	4.31
Salt	0.89	0.89	0.89	0.89	0.89
Shortening	0.59	0.59	0.59	0.59	0.59
Water(ml)	33.63	33.63	33.63	33.63	33.63

Source: Hussan (2006). The improvers were incorporated into the wheat flour as 0.5, 1, 2 and 3%, respectively

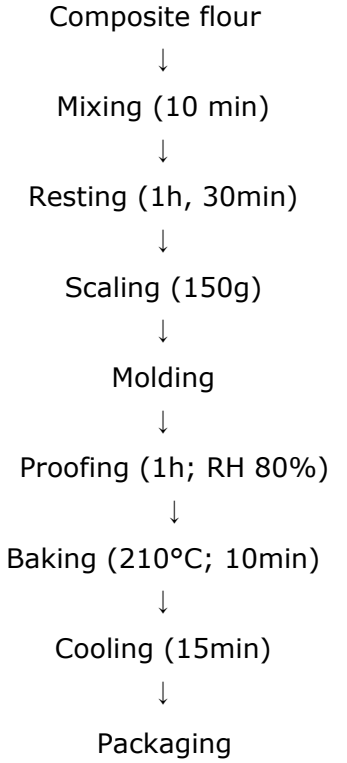

Figure. 1: Production of bread Source: Akubor and Obiegbuna (2014)

C. Storage Stability Studies of breads

Fresh bread samples were placed in low-density polyethylene material and stored at room temperature (28 ± 2°C) for a period of seven days. The changes in bread staling, particularly with regards to moisture changes in bread crumb and crust, were monitored at 24-hour intervals. The bread samples were also visually examined for any signs of fungal growth.

D. Determination of bacterial load

Microbial analysis was performed following a modified procedure as described by Anibijuwon and Sunday (2012), which involved the use of the pour plate technique. For sample preparation, 1 g of each bread sample was aseptically transferred into 9 mL of sterile distilled water, which gave an initial 10^{-1} dilution. Serial dilutions were then made step by step up to 10^{-5} by using sterile pipetting techniques.

Before the dilution, the samples were homogenized in peptone water for uniform microbial distribution in the samples. From the diluted samples, 0.1 mL of each sample was inoculated onto nutrient agar (NA) for total viable bacterial count and MacConkey agar (MCA) for coliform count, respectively. The molten medium was then poured into the petri dishes, mixed, and allowed to solidify. After 48-72 hours of incubation at 37°C, the colonies formed in the medium were enumerated by a Stuart Scientific colony counter, and the results were expressed as colony-forming units per gram (cfu/g). The analysis was done in triplicate for accuracy and reproducibility of results.

E. Characterization and Identification of Isolates

Colonies that were distinct from one another, obtained from the culture plates, were purified through repeated sub-culturing on fresh tryptone soya agar plates. The purified cultures were Gram stained to observe the morphological characteristics of the organisms. The organisms were identified through standard biochemical tests, which included catalase, coagulase, oxidase, citrate, and glucose fermentation tests, according to standard procedures. Fungal cultures that developed within 2 to 3 days of incubation were observed under a microscope with a magnification of ×40 to identify the organisms based on morphological characteristics according to standard procedures (Barnett & Hunter, 1992). The yeast count and mold count were obtained after incubating the plates at 25°C for 48 to 72 hours, followed by recording the results in cfu/g, with all determinations being performed in triplicate.

F. Determination of staling or syneresis of bread

Syneresis, was evaluated using 10 g of each bread sample and weighed into pre-weighed centrifuge tubes and stored upright at 4°C for 14 days. The extent of water release was determined by measuring the weight loss after separating the exuded liquid. Syneresis was calculated as the percentage of water expelled relative to the initial sample weight, as shown below:

$$\text{Syneresis (\%)} = \frac{\text{Exuded water (g)}}{\text{Total weight of sample}} \times 100$$

This method is consistent with previously reported approaches (Turgeon & Beaulieu, 2001; Aichinger et al., 2003).

G. Experimental Design and Statistical Analysis

A completely randomized design (CRD) was used for the experimental setup. The data obtained from the study was analyzed through the application of analysis of variance (ANOVA) with the help of statistical software, i.e., Statistical Package for the Social Sciences (SPSS) version 17.0. The differences between the means of the treatments were separated through Duncan's multiple Range test, where $p < 0.05$ was used to determine significance.

III. RESULTS AND DISCUSSION

A. Results

1. Microbiological properties of composite flour breads

The microbial quality of bread samples produced from composite flour with varying concentrations of improvers is summarized in Table 1. The results indicate that bacterial populations vary depending on the type and level of improver incorporated. Samples containing guar gum, an increase in total bacterial count was observed with higher inclusion levels, rising from 2.33×10^4 cfu/g at 1% substitution to 2.83×10^4 cfu/g at 3%. In contrast, bread formulated with ascorbic acid consistently exhibited the lowest bacterial load, with values ranging between 2.47×10^2 and 2.87×10^2 cfu/g across the tested concentrations. The bacterial counts recorded for bread containing Panok were intermediate, being lower than those observed in guar gum samples but exceeding those found in other treatments. Similarly, samples treated with STK Royal showed relatively low bacterial counts (3.34×10^2 to 3.37×10^2 cfu/g), second only to the ascorbic acid-treated bread.

More so, fungal contamination, the control sample (without improvers) exhibited the highest mould count, reaching 5.83×10^3 cfu/g. In comparison, all treated samples showed reduced mould growth. Bread containing guar gum recorded mould counts of 2.37×10^2 and 2.67×10^2 cfu/g, while those with ascorbic acid ranged from 3.23×10^2 to 3.32×10^2 cfu/g. For Panok-treated samples, mould counts were relatively higher, falling between 1.13×10^3 and 1.43×10^3 cfu/g. Meanwhile, STK Royal-treated bread exhibited values within the range of 3.43×10^2 to 3.83×10^2 cfu/g. The overall, the incorporation of improvers influenced both bacterial and fungal loads, with ascorbic acid demonstrating the most pronounced inhibitory effect among the treatments.

Table 2: Microbiological properties (cfu/g) of composite flour bread incorporated with different levels of improvers

Improver	Level (%)	Total bacterial	Total mold count	Total coliform count
GG	0.5	$2.33x10^4$	$2.67x10^2$	NG
	1	$2.63x10^4$	$2.37x10^2$	NG
	2	$2.83x10^4$	$2.57x10^2$	NG

	3	$2.88x10^4$	$2.59x10^2$	NG
AA	0.5	$2.67x10^2$	$3.23x10^2$	NG
	1	$2.87x10^2$	$3.32x10^2$	NG
	2	$2.47x10^2$	$3.32x10^2$	NG
	3	$2.87x10^2$	$3.23x10^2$	NG
P	0.5	$2.07x10^4$	$1.43x10^3$	NG
	1	$2.07x10^4$	$1.23x10^3$	NG
	2	$2.07x10^4$	$1.13x10^3$	NG
	3	$2.07x10^4$	$1.33x10^3$	NG
STK	0.5	$3.37x10^2$	$3.83x10^2$	NG
	1	$3.36x10^2$	$3.43x10^2$	NG
	2	$3.35x10^2$	$3.51x10^2$	NG
	3	$3.34x10^2$	$3.53x10^2$	NG
Control	-	$2.67x10^3$	$5.83x10^3$	NG

Means with same superscript within a column were not significantly ($p>0.05$) different. NG=No growth. The improvers were added at 3% level. GG=guar gum, AA= ascorbic acid, P= Panok^R, STK= STK Royal.

B. Storage stability of breads

1. Staling characteristics breads during storage

The staling characteristic which are determined as changes in the moisture of the bread are presented in Table 1.2. The freshness of all the breads samples decreased with storage as the moisture content of all the bread samples decreased with storage. All the breads containing improvers had higher freshness value than the control at any storage period. At the end of the 4th day of storage, the control had the lowest freshness value of 60.75% which was at 8.51 % crumb moisture content while the bread containing STK had the highest freshness value of 73% at 11.75% crumb moisture content.

Table 3: Staling characteristics of bread containing different improvers

(% Freshness) Storage period (days)					
Improver	**0**	**1**	**2**	**3**	**4**
Guar gum	(14.0)100^{ab}	(13.84) 98.75^d	(11.87) 84.75^c	(11.48) 82.00^d	(9.8)70.00^{bc}

Ascorbic acid	(17.3)100^{cd}	(14.53) 84.00^{ab}	(12.98) 75.00^{a}	(12.19)70.50^{ab}	(10.68)61.75^{a}
Panok^{R}	(16.0)100^{d}	(13.88) 86.75^{b}	(12.48) 78.00^{ab}	(10.80) 67.50^{a}	(9.96)62.25^{a}
STK royal	(16.1)100^{d}	(14.93) 92.75^{c}	(13.32) 82.75^{c}	(12.59)78.25^{c}	(11.75)73.00^{c}
Control	(14.0)100^{ab}	(11.59) 82.75^{a}	(11.09) 79.25^{b}	(10.26) 73.25^{b}	(8.51) 60.75^{b}

Means within a row with the same superscript were not significantly ($p>0.05$) different. The values in parenthesis are the moisture content (%) of the bread crumb.

2. Changes in microbial quality during storage

The effect of storage on the microbiological quality of bread incorporated with different improvers is shown in Table 1.3. There was no coliform growth in the control and the bread incorporated with the improvers until the 4th day of storage. The coliform count for the control was 56.67cfu/g at the end of the 7th day of storage. The coliform count for the breads containing the improvers ranged from 41- 56.67cfu/g. There was no viable growth in all the fresh breads samples incorporated with improvers and the control at zero days of storage. Similarly, there was no mould growth in the bread incorporated with guar gum throughout the 7 day storage period. However, at the end of the first day of storage, there was no viable growth for the bread containing the improvers while the control had total viable count of 60.23cfu/g. The mould count for the control at the end of the first day of storage was 61.33 cfu/g. The mould counts for the breads containing improvers excluding the bread containing guar gum varied from 40.33- 50.67 cfu/g at the end of the first day of the storage. There was no total viable count for the bread containing improvers at the end of the first day of storage. However, from the 2nd day of storage, there were mould and bacteria growth. At the end of the 7th days of storage, the control had mould counts of 58.67cfu/g and TVC of 105.50 cfu/g. The breads containing the improvers had significantly ($p<0.05$) lower moulds and total viable counts of 41.67-49.67 and 41.0- 59.33, respectively. For each of the storage period, the mould counts and total viable counts for the improvers were in the decreasing order guar gum < ascorbic acid < Panok < STK.

Table 4: Effect of storage on the microbiological quality of bread samples with different improvers

	Microbiological counts(cfu/g)		
Storage period/improver	**Coliform**	**Moulds**	**Total viable count**
GG	0.00^{a}±0.00	0.00^{a}±0.00	0.00^{a}±0.00
AA	0.00^{a}±0.00	0.00^{a}±0.00	0.00^{a}±0.00
P	0.00^{a}±0.00	0.00^{a}±0.00	0.00^{a}±0.00
STK	0.00^{a}±0.00	0.00^{a}±0.00	0.00^{a}±0.00
C	0.00^{a}±0.00	0.00^{a}±0.00	0.00^{a}±0.00
Day 1			

GG	0.00^{a}±0.00	0.00^{a}±10.97	0.00^{a}±0.00
AA	0.00^{a}±0.00	43.33^{a}±11.02	0.00^{a}±0.00
P	0.00^{a}±0.00	45.67^{a}±11.55	0.00^{a}±0.00
STK	0.00^{a}±0.00	50.67^{a}±10.50	0.00^{a}±0.00
C	0.00^{a}±0.58	61.33^{a}±8.68	60.33^{a}±0.58
Day 2			
GG	0.00^{a}±0.00	0.00^{a}±0.00	60.03^{a}±4.36
AA	0.00^{a}±0.00	40.33^{a}±3.21	40.33^{a}±3.21
P	0.00^{a}±0.00	42.67^{a}±5.51	50.00^{a}±2.65
STK	0.00^{a}±0.00	44.00^{a}±5.29	53.67^{a}±3.21
C	0.00^{a}±0.00	54.00^{a}±4.36	54.00^{a}±4.36
Day 3			
GG	0.00^{a}±0.00	0.00^{a}±0.00	53.67^{a}±3.06
AA	0.00^{a}±0.00	40.33^{a}±3.21	57.33^{a}±6.03
P	0.00^{a}±0.00	42.67^{a}±5.51	200.00^{a}±1.41
STK	0.00^{a}±0.00	44.00^{a}±5.29	53.67^{a}±3.06
C	0.00^{a}±0.00	45.67^{a}±11.55	57.33^{a}±6.03
Day 4			
GG	41.00^{a}±8.00	0.00^{a}±0.00	53.67^{a}±3.06
AA	56.67^{a}±5.13	38.00^{a}±3.61	57.33^{a}±6.03
P	52.33^{a}±3.51	37.67^{a}±4.04	200.00^{a}±1.41
STK	41.00^{a}±8.00	44.67^{a}±4.73	53.67^{a}±3.06
C	56.67^{a}±5.13	54.33^{a}±7.77	57.33^{a}±6.03
Day 5			
GG	38.33^{a}±0.58	41.00^{a}±8.89	50.33^{a}±4.93
AA	40.67^{a}±0.58	39.67^{a}±2.31	54.67^{a}±5.51
P	50.33^{a}±3.21	47.00^{a}±4.36	60.67^{a}±3.51
STK	53.67^{a}±3.06	55.00^{a}±6.00	105.50^{b}±4.95
C	57.33^{a}±6.03	65.00^{a}±6.08	50.33^{a}±4.93
Day 6			
GG	41.00^{a}±8.00	0.00^{a}±0.00	41.00^{a}±8.00
AA	56.67^{a}±5.13	41.67^{a}±8.02	56.67^{a}±5.13
P	52.33^{a}±3.51	44.00^{a}±6.25	52.33^{a}±3.51
STK	41.00^{a}±8.00	49.67^{a}±4.59	59.33^{a}±6.431
C	56.67^{a}±5.13	58.67^{a}±2.52	105.50^{b}±4.95
Day 7			
GG	41.00^{a}±8.00	0.00^{a}±0.00	41.00^{a}±8.00
AA	56.67^{a}±5.13	41.67^{a}±8.02	56.67^{a}±5.13
P	52.33^{a}±3.51	44.00^{a}±6.25	52.33^{a}±3.51
STK	41.00^{a}±8.00	49.67^{a}±4.59	59.33^{a}±6.431
Control	56.67^{a}±5.13	58.67^{a}±2.52	105.50^{b}±4.95

Means within a column with the same superscript were not significantly different (p>0.05)

AA= composite flour bread + ascorbic acid improver, GG= composite flour bread + Guar gum improver, P= composite bread + Panok^{R} improver (3%), STK= composite bread+ STK improver

IV. DISCUSSION

A. Microbiological properties of composite flour breads

The microbial quality of composite bread samples formulated with varying proportions of improvers is presented in Table 1.0. Variations in bacterial load were observed depending on the type and concentration of improver used. An upward trend in bacterial count was noted in samples containing guar gum as the inclusion level increased. In contrast, breads treated with ascorbic acid consistently exhibited comparatively lower bacterial populations. Samples containing Panok showed intermediate bacterial levels—lower than those recorded for guar gum formulations but higher than most other treatments. Similarly, STK-containing breads had relatively low bacterial counts, though slightly higher than those of ascorbic acid-treated samples. The control sample generally recorded higher bacterial counts than most treated samples, except those with guar gum.

All observed microbial counts were within the acceptable limits established by the Standards Organization of Nigeria, which specifies that aerobic bacterial counts in bread should not exceed 100 cfu/g and that coliforms must be absent. The absence of coliform organisms across all samples indicates good hygienic quality and suggests that the bread was free from faecal contamination, making it safe for consumption.

The bacterial isolates identified included species of *Bacillus*, *Micrococcus*, and *Staphylococcus*. These microorganisms are commonly associated with contamination in bakery products and may originate from raw ingredients such as flour, sugar, and yeast, or from environmental exposure during processing. The ability of *Bacillus* species to produce heat-resistant spores enables their survival during baking. This observation supports earlier findings that *Staphylococcus* species are widely distributed in the environment and are commonly found on human skin, fingernails, and nasal passages, from where they can contaminate food products.

Fungal analysis revealed that the control sample had the highest mould load. No coliform organisms were detected in any of the samples, further confirming their microbiological safety. The fungi isolated included *Aspergillus*, *Penicillium*, *Rhizopus*, and *Mucor* species, which are typical contaminants of bread. These organisms may have been introduced at different stages of production, handling, or storage. Similar findings have been reported in previous studies on bread microbiology.

Physical examination of spoiled samples revealed discolorations such as black, green, and yellow patches, indicative of mould growth. Microscopic analysis confirmed the presence of *Aspergillus flavus*, *Penicillium* spp., *Rhizopus stolonifer*, and *Mucor mucedo*. These fungi are known to contribute to bread spoilage and reduced shelf life.

Food safety is influenced by several factors, including the quality of raw materials, processing conditions, handling practices, and storage environment (Oluwajoba et al., 2012). Microbial enumeration serves as a reliable indicator of both product safety and spoilage potential. In this study, total viable counts of the bread samples slightly exceeded the commonly reported modal values for wheat flour products (10^2 cfu/g) (Olaoye & Onilude, 2008), which may be attributed to environmental exposure during production. Comparable values for fresh commercial wheat bread have been reported to range between 1.2×10^2 and 1.5×10^2 cfu/g.

B. Storage stability of breads

1. Staling characteristics breads during storage

Changes in bread freshness during storage, as indicated by variations in moisture content (Table 1.2), showed a progressive decline over time. All samples exhibited a reduction in moisture content during storage, which corresponded to decreased freshness. However, breads formulated with improvers maintained higher moisture levels and better freshness compared to the control throughout the storage period.

Bread is inherently perishable, with its shelf life largely limited by staling—a physicochemical process characterized by crumb firming and moisture loss. This process is associated with starch retrogradation, particularly the recrystallization of amylopectin, as well as redistribution of water within the bread matrix (Onimawo & Akubor, 2012). In wheat-based bread, the gluten network helps to restrict moisture migration from crumb to crust. In contrast, reduced gluten content in composite bread accelerates water movement, making such products more susceptible to staling.

The incorporation of dough improvers appeared to slow down moisture loss, likely due to their water-binding capacity and their ability to inhibit starch retrogradation (Guarda et al., 2003). During storage, moisture migration from the crumb to the crust resulted in increased dryness, firmness, and crumbly texture, consistent with previous reports (Pateras, 1998). The reduced ability of wheat–cassava composite flour to retain water may be attributed to the dilution of gluten following cassava incorporation, thereby lowering the water-holding capacity of the flour blend (Mondal & Datta, 2008).

C. Changes in microbial quality during storage

The impact of storage on the microbial status of bread samples is presented in Table 1.3. Across all storage periods, both mould and total viable counts followed a consistent trend depending on the improver used, generally in the order: guar gum < ascorbic acid < Panok < STK.

The increase in microbial population during storage may be attributed to the survival of heat-resistant microorganisms that persisted after baking and proliferated under favourable storage conditions. This trend is consistent with earlier findings on composite bread systems. Despite this increase, microbial counts remained within acceptable safety limits.

The comparatively lower bacterial and fungal counts observed in breads containing improvers, both before and during storage, suggest that these additives may have

preservative effects. Microbial contamination in bread can arise from multiple sources, including raw materials, processing equipment, handling practices, and storage conditions (Udeme et al., 2014).

V. CONCLUSION AND RECOMMENDATION

A. Conclusion

Based on the results of the study, it is concluded that:

- Incorporation of guar gum, ascorbic acid, panok and STK bread improvers improved the dough development time and dough stability.
- All the bread improvers increased the yield, oven spring, volume, specific volume, freshness, and lightness but reduced the yellowness and redness of the wheat –cassava flour composite bread.
- The breads incorporated with the improvers were safe for human consumption and were microbiologically more stable than the control in storage for 7 days.
- The breads containing all the improvers at any level of incorporation were accepted by the panelists with the bread containing 3% improvers being preferred to other levels.The effects of the improvers on the sensory quality of the bread varied with the improvers where the bread incorporated with the STK improver was the most acceptable.

RECOMMENDATION

Base on the results of this study, it is recommended that:

- Bread improvers such as guar gum, ascorbic acid, panok and STK, particularly should be used to improve the quality of bread from wheat and cassava flour blend.
- The chemical toxicity of breads containing the various improvers evaluated in the present study should be studied.
- Comparative study should be carried out on the use of natural and artificial bread improvers to improving the quality of wheat –cassava flour composite bread.

DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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