OPEN ACCESS
Scholars Bulletin
Abbreviated Key Title: Sch Bull
ISSN 2412-9771 (Print) |ISSN 2412-897X (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Subject Category: Biotechnology

Assessment of the Microbiological Quality of Bread Sold in the City of Kisangani in the Democratic Republic of Congo (DRC)

Mongengo Vincent Roger[1]*, Kpathy Agenong'a Xénophon[2], Onautshu Odimba Didy[1], Etobo Kalunga Jean Pierre[1]

[1]University of Kisangani, Faculty of Natural Sciences and Biotechnology, Specialization: Biotechnology, Microbiology and Plant Pathology Laboratory, Kisangani, DRC
[2]University of Bunia, Faculty of Medicine, Bunia, DRC

DOI: https://doi.org/10.36348/sb.2026.v12i04.001 | **Received:** 05.02.2026 | **Accepted:** 22.03.2026 | **Published:** 27.04.2026

***Corresponding author:** Mongengo Vincent Roger
University of Kisangani, Faculty of Natural Sciences and Biotechnology, Specialization: Biotechnology, Microbiology and Plant Pathology Laboratory, Kisangani, DRC

Abstract

Bread is a food commonly sold and consumed in Kisangani. Throughout its production and distribution chain, it undergoes multiple handling processes. To mitigate the potential risks associated with its consumption, a study was conducted to assess its microbiological quality. The serial dilution technique enabled the isolation and enumeration of bacteria, while the assessment of hygienic quality was carried out in accordance with Codex Alimentarius standards. The results obtained showed that the high bacterial load was found in retailers 11, 12, 21, 31, and 51, with 11.71×10^2 CFU (salmonella), 41.23×10^5 CFU (FMAT), 6.36×10^2 CFU (enterobacteria), 43.46×10^5 CFU (yeasts and molds), and 27.55×10^2 CFU (staphylococci). The bread sold and consumed in four of the five bakeries sampled and that sold by retailers does not meet food hygiene standards in Kisangani.

Keywords: Assessment, Microbiological Quality, Bread, Kisangani.

I. INTRODUCTION

The Democratic Republic of Congo is experiencing a population boom, like many third world countries. This has led to changes in housing, work, and nutrition, resulting in the emergence of lucrative activities and new eating habits involving the consumption of transportable, ready-to-eat foods such as bread [1].

Bread is rich in calories, carbohydrates, fiber, fat, and protein [2], and plays an important role in the human diet [3-5]. Its preparation and sale provide a regular source of income for millions of men and women [6].

Today, its consumption has become sensitive due to production and sales conditions that do not meet hygiene requirements, making bread a source of health risks [7].

Studies conducted on various foodstuffs have revealed the presence of bacteria of the genera *Salmonella*, *Shigella*, *Serratia*, *Listeria*, *Hafnia*, *Mycobacterium*, *Escherichia*, *Edwarsiella*, *Citrobacter*, *Campylobacter*, *Clostridium*, *Proteus*, *Providencia*, and *Yersinia* [8, 9]. These bacteria cause infectious diseases [10-12], and are found in samples of fish, chicken, beef, pork, vegetables, cassava chips, wheat flour, and deli meats.

It is in this context that the present study aims to evaluate the microbiological and hygienic quality of bread sold and consumed in Kisangani in light of the handling it undergoes during its manufacture, transport, and storage.

II. MATERIALS AND METHODS

II.1. Study Environment

This study was conducted in the city of Kisangani (Figure 1), the capital of Tshopo Province, located in the northeast of the Congolese central basin,

covering an area of 1,910 km² and rising to an altitude of between 376 and 460 m, with several variations in relief on the Boyoma Plateau and the Medical Plateau. Its geographical coordinates are 0°31'00" north latitude and 25°15'00" east longitude [13].

Kisangani has a triangular shape due to the location of the Congo River to the south and the Tshopo River to the north. Administratively, it is divided into six communes, in addition to the Lubuya bera sector. These are Makiso, Tshopo, Mangobo, Kabondo, Kisangani (on the right bank of the Congo River) and Lubunga (on the left bank) with 67 neighborhoods [14].

In the Kisangani region, rainfall is abundant but unevenly distributed throughout the year [15]. The climate is characterized by generally high temperatures that remain virtually constant throughout the year. Average temperatures range between 23.7 and 25.3°C, representing a very small temperature range (1.6°C). The annual average is 24.3°C [16, 17].

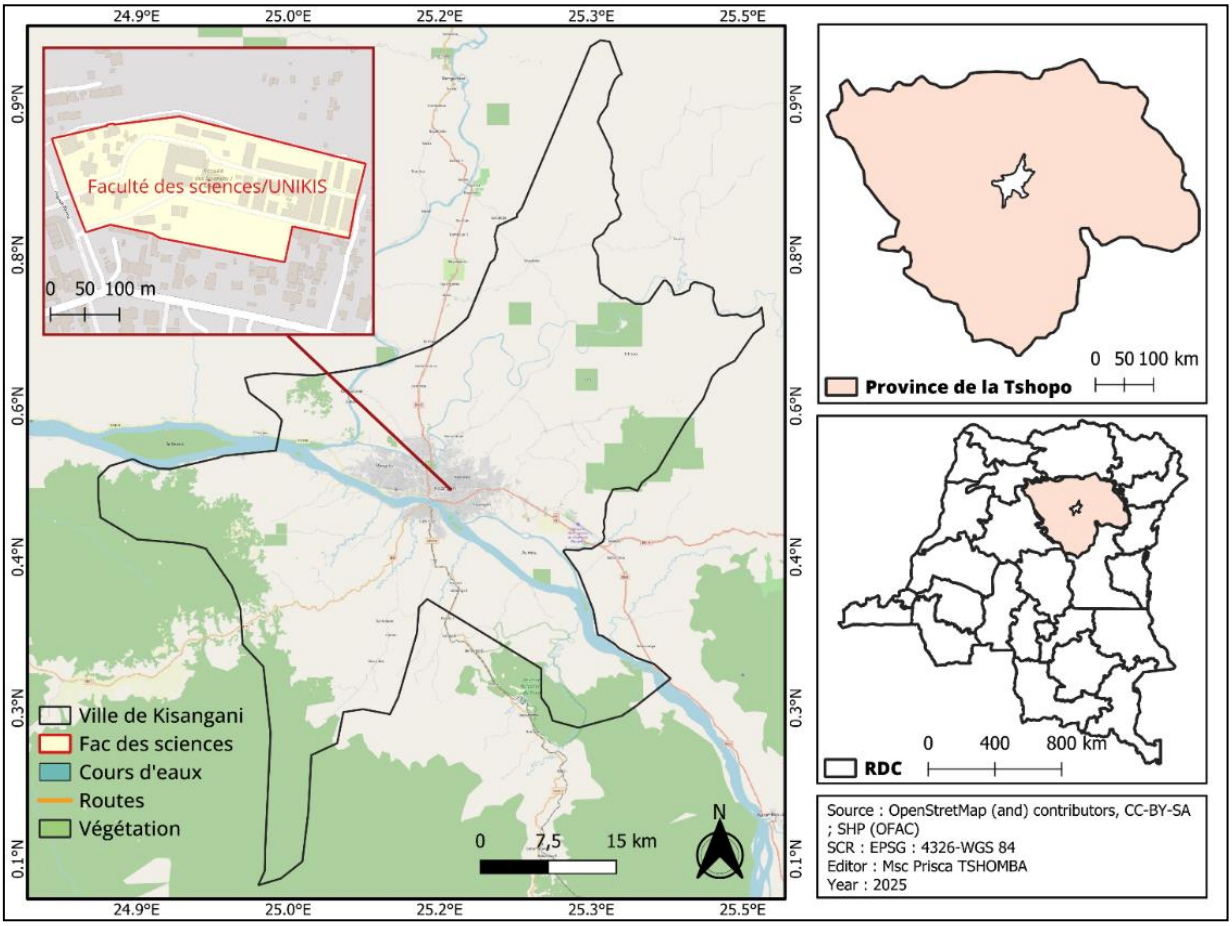

Figure 1: Map of the city of Kisangani

II.2. Equipment

The study was conducted from November 2023 to January 2025 in five bakeries and ten retailers (two retailers per bakery) selling bread in the municipality of Makiso. These bakeries were selected at random. The bread samples were subjected to various analyses.

The samples of bread purchased and bagged were covered with aluminum foil and immediately sent to the Microbiology and Phytopathology Laboratory of the Faculty of Natural Sciences and Biotechnology at the University of Kisangani for analysis.

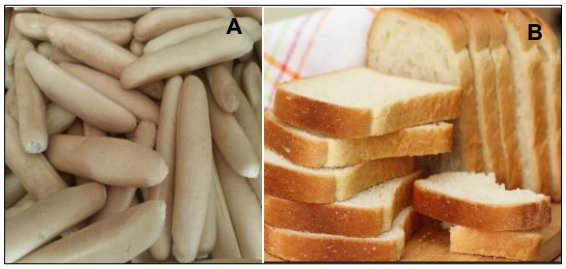

Figure 2: Different bread samples (A: baguette; B: sandwich bread) (personal source)

II.3. METHODS

Bacteriological analyses of the bread samples were carried out in two stages : isolation and enumeration of bacteria.

II.3.1. Isolation of Germs

25 g of the sample was weighed using the balance (Sartorius), then placed in the jar containing 225 mL of sterile buffered peptone water. The solution was then homogenized (10^{-1} dilution). Successive decimal dilutions (10^{-2}, 10^{-3}, 10^{-4}, 10^{-5}) were also performed by diluting 1 mL of the previous dilution in 9 mL of sterile buffered peptone water.

The microorganisms sought in samples of bread sold and consumed in Kisangani are FMAT, enterobacteria, salmonella, staphylococci, yeast, and mold.

II.3.2. Microorganism Count

Using successive decimal dilutions, inoculate 1 mL of the inoculum into the appropriate medium to detect the bacteria. Thus, 15 mL of nutrient agar (FMAT detection), Chapman agar containing a high concentration of NaCl at 7.5 % (staphylococcus detection), Lactose agar with eosin and methylene blue (for detecting enterobacteria) and Sabouraud agar (for detecting yeast and mold) in supercooled form and cooled to 45°C are poured aseptically into each Petri dish.

However, for salmonella, 1 mL of the 10^{-1} dilution is enriched in selenite broth, then incubated at 37°C for 24 hours. Take 1 mL of the enriched inoculum and pour it aseptically into sterile Petri dishes. Finally, 15 mL of SS Agar medium (for salmonella detection) in supercooled and cooled to 45°C is poured into the dishes.

After homogenization and complete solidification of the medium, invert and incubate the boxes at 37°C for 24 to 48 hours depending on the bacteria sought [18].

The purpose of this analysis is to isolate and count bacteria that are indicators of good hygiene practices and that pose a risk to public health.

The number of bacterial colonies per Petri dish growing in or on the agar was counted, and dishes with fewer than 15 colonies and more than 300 colonies were discarded [19]. Finally, the number of colony-forming units (CFU/g) of bacteria in the analyzed product was expressed using the following formula :

$$\mathbf{N} = \frac{\sum c}{V(ml) \times (n1 + 0{,}1 \times n2)} \mathbf{x\ Fd}$$

II.4. Assessment of Bread Hygiene Quality

The hygienic quality of bread is assessed according to a three-class system. Microbiological criteria are interpreted in accordance with Codex Alimentarius standards [20, 21]. For this classification, m is considered to be the microbiological criterion. The product is therefore classified as : satisfactory, acceptable and unsatisfactory.

II.5. Statistical Analyses

All experiments were repeated five times. We then calculated the mean, variance and standard deviation. However, the analysis of variance was performed using R Studio software version 4.1.1. This test was applied to verify the difference in the number of bacteria isolated from bakeries compared to retail outlets.

III. RESULTS AND DISCUSSION

III.1. Germ Count in the Bread Samples Analysed

The results of the bacterial loads obtained from the germ count (FMAT, enterobacteria, salmonella, staphylococci, yeast and mould) are shown in tables 1, 2, 3, 4 and 5 respectively.

III.1.1. Bacterial Loads of Total Aerobic Mesophilic Flora

The bacterial load obtained from the FMAT count in bread samples from different sites is presented in table 1.

Table 1: Bacterial load (CFU/g) of total aerobic mesophilic flora from bread samples from different sites

Standort	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Bakery 1	$42{,}23.10^3$	$2{,}30.10^2$	$1{,}60.10^2$	$5{,}82.10^2$	$3{,}33.10^2$
Retailer 11	$33{,}46.10^5$	$2{,}60.10^2$	$1{,}95.10^2$	$10{,}91.10^2$	$5{,}05.10^2$
Retailer 12	$41{,}23.10^5$	$17{,}23.10^2$	$4{,}55.10^5$	3.10^2	$9{,}47.10^2$
Bakery 2	0	$1{,}60.10^2$	$5{,}67.10^2$	$2{,}10.10^2$	$3{,}29.10^2$
Retailer 21	$1{,}50.10^2$	$6{,}19.10^2$	$2{,}65.10^2$	$2{,}25.10^2$	$5{,}73.10^2$
Retailer 22	$2{,}55.10^2$	$4{,}62.10^2$	$8{,}09.10^2$	$5{,}73.10^2$	4.10^2
Bakery 3	$2{,}20.10^2$	$1{,}90.10^2$	$1{,}50.10^2$	$1{,}90.10^2$	$1{,}70.10^2$
Retailer 31	$4{,}32.10^2$	0	$1{,}90.10^2$	$1{,}80.10^2$	$6{,}29.10^2$
Retailer 32	$3{,}43.10^2$	$1{,}70.10^2$	0	$3{,}52.10^2$	$2{,}40.10^2$
Bakery 4	$21{,}96.10^2$	$2{,}45.10^2$	$4{,}73.10^2$	$2{,}95.10^2$	$10{,}33.10^2$
Retailer 41	$30{,}33.10^3$	16.10^2	$66{,}42.10^3$	$70{,}17.10^3$	$14{,}59.10^2$
Retailer 42	$19{,}96.10^2$	$10{,}18.10^2$	$19{,}14.10^2$	$76{,}83.10^4$	$15{,}73.10^2$
Bakery 5	0	$1{,}50.10^2$	0	$3{,}05.10^2$	$2{,}35.10^2$
Retailer 51	0	$7{,}64.10^2$	$2{,}85.10^2$	$2{,}95.10^2$	$15{,}57.10^2$

Retailer 52	3,86.10²	18,82.10²	1,90.10²	2.10²	10,55.10²

Table 1 shows that the samples analysed are contaminated with total aerobic mesophilic flora to varying degrees. The highest levels of contamination were observed at retailer 12 (4.55×10^5 ; 41.23×10^5 CFU/g), retailer 42 (15.73×10^2 ; 76.83×10^4 CFU/g) and retailer 52 (18.82×10^2 CFU/g).

The high levels of contamination obtained are thought to be due to handling, transport and distribution conditions that alter the hygienic and organoleptic quality of the bread. However, analysis of variance revealed that there are no significant differences between the sampling sites (F : 2.13; p-value = 0.08).

Aerobic mesophilic flora refers to all microorganisms corresponding to common contamination germs. The AMMF count reflects the overall microbiological quality of a natural product [22]. Indeed, excessive levels of these germs are evidence of poor hygiene practices [23], and poor storage conditions, which can lead to contamination by the entire community of microorganisms, thereby playing a role in altering the physical and chemical properties of the product [24].

For their part, Umba *et al.,* [8], observed that contaminating flora was reduced in all samples coming out of the oven, regardless of the bakery, and that this number increased slightly in the case of artisan bakeries (average of 12-14 compared to 5 for industrial bakeries). Contamination would mainly occur as a result of the various handling operations between the bakery and the point of sale.

According to the same authors, it was also found that manipulation was more common in small bakeries than in large ones, which could explain the higher level of contamination. Furthermore, the temperatures at the exit of artisan ovens were lower than those at the exit of industrial ovens. This could be explained by the fact that this bread remains exposed for long periods in uncovered bins, without any protection, and can therefore be contaminated by ambient flora. It is bread sold by retailers outside bakeries, often along roadsides and in questionable conditions, that is most heavily contaminated.

Our results contradict those found by Achouke [25], who found that the FMAT load in Kandji bread samples was observed in samples k2 with 4.1×10^7 CFU/g and k7 with 3.1×10^7 CFU/g. These differences may be due to the hygiene practices of the various individuals who handled the bread samples after their preparation, on the one hand, and the sampling environment and climatic factors, on the other.

III.1.2. Bacterial Load of Enterobacteria

The bacterial load obtained from the count of enterobacteria in bread samples from different sites is shown in table 2.

Table 2: Bacterial load (CFU/g) of enterobacteria from bread samples from different sites

Standort	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Bakery 1	1,90.10²	0	0	0	0
Retailer 11	1,70.10²	0	0	2,10.10²	0
Retailer 12	0	0	0	0	0
Bakery 2	0	0	2,10.10²	0	0
Retailer 21	0	6,36.10²	0	0	0
Retailer 22	0	5,41.10²	0	0	0
Bakery 3	0	0	0	0	0
Retailer 31	0	0	0	0	0
Retailer 32	0	0	0	0	0
Bakery 4	4,52.10²	0	0	0	0
Retailer 41	0	0	2,30.10²	0	2,30.10²
Retailer 42	0	0	0	0	0
Bakery 5	0	0	0	0	0
Retailer 51	0	0	0	2,10.10²	5,18.10²
Retailer 52	1,50.10²	0	0	0	0

The results in table 2 show that 12 of the samples analysed are contaminated with enterobacteria. However, there are no enterobacteria in the sample residues. These bacterial loads range from 0 to 6.36×10^2 CFU/g. Thus, high loads are observed at retailer 21 (E2) ; retailer 51 (E4, E5) ; bakery 4 (E1) ; retailer 41 (E3) and retailer 11 (E4). Furthermore, analysis of variance showed that there was no significant difference between sites (p-value = 0.21).

Achouke [25], found that all samples of Kandji bread were contaminated with enterobacteria, with only samples k2, k5 and k7 being uncontaminated. According to him, the presence of enterobacteria could be due to

poor hygiene at the point of sale and storage of the bread after production.

Benbrahim [26], found a bacterial load of enterobacteria of 50 CFU/g in his study on the microbiological quality of pastry products sold in Fez. According to this author, the contamination resulted from the handling of the bread after it came out of the oven.

III.1.3. Salmonella Bacterial Load

The results of the bacterial load obtained from the *Salmonella* count in bread samples from different sites are shown in table 3.

Table 3: Bacterial load (CFU/g) of Salmonella from bread samples from different sites

Standort	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Bakery 1	$7{,}41.10^2$	0	0	0	0
Retailer 11	$11{,}71.10^2$	0	0	0	$1{,}90.10^2$
Retailer 12	$1{,}95.10^2$	0	$1{,}50.10^2$	0	0
Bakery 2	0	0	0	0	0
Retailer 21	0	0	0	0	0
Retailer 22	0	0	0	0	0
Bakery 3	0	0	0	0	0
Retailer 31	0	0	0	0	0
Retailer 32	$1{,}70.10^2$	0	0	0	0
Bakery 4	0	0	0	0	0
Retailer 41	0	0	0	0	0
Retailer 42	0	0	0	0	0
Bakery 5	0	0	0	0	0
Retailer 51	$2{,}40.10^2$	0	0	0	0
Retailer 52	$4{,}09.10^2$	0	0	0	0

The results in Table 3 show that the Salmonella bacterial load varies from 0 to 11.71×10^2 CFU/g. Furthermore, there is no Salmonella in samples 2 and 4 for the entire sampling site, and only bakery 1 and retailers 11, 12, 32, 51 and 52 are contaminated with Salmonella compared to the other sites. However, analysis of variance showed that there are significant differences between sites (p-value = 0.03).

Barmati *et al.,* [27], found no pathogenic bacteria such as sulphite-reducing anaerobes, staphylococci or *Escherichia coli*, revealing the good sanitary quality of the samples, and fermentation was the only way to preserve the food against spoilage microorganisms [28].

Secke [29], in his study on the bacteriological quality of bread sold in Dakar, observed the absence of *Salmonella* in all of his analysed samples. The difference between his results can be explained by compliance with hygiene rules and the cleanliness of the sales environment.

III.1.4. Staphylococcus Bacterial Load

The results of the Staphylococcus count in bread samples from different sites are given in table 4.

Table 4: Bacterial load (CFU/g) of Staphylococcus from bread samples from different sites

Standort	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Bakery 1	0	0	0	0	0
Retailer 11	0	0	0	0	0
Retailer 12	0	0	0	0	0
Bakery 2	0	$2{,}30.10^2$	0	0	$3{,}62.10^2$
Retailer 21	0	$3{,}43.10^2$	0	0	0
Retailer 22	0	0	0	0	0
Bakery 3	$1{,}90.10^2$	0	0	0	0
Retailer 31	$2{,}05.10^2$	0	0	0	0
Retailer 32	$2{,}20.10^2$	0	0	0	0
Bakery 4	$2{,}10.10^2$	$2{,}50.10^2$	$1{,}90.10^2$	0	2.10^2
Retailer 41	$4{,}71.10^2$	$4{,}48.10^2$	$8{,}91.10^2$	0	$3{,}95.10^2$
Retailer 42	$3{,}19.10^2$	0	$2{,}30.10^2$	0	$2{,}70.10^2$
Bakery 5	0	0	0	0	0
Retailer 51	0	$27{,}55.10^2$	0	0	$1{,}90.10^2$
Retailer 52	0	$10{,}77.10^2$	0	0	$1{,}60.10^2$

The results in table 4 show that the highest bacterial load of Staphylococci is observed at retailers 41 and 51. However, there are no bacterial loads of Staphylococci in sample 4 at any of the sites. This load varies from 0 to 3.62 x 10^2 CFU/g in bakeries and from 0 to 27.55 x 10^2 CFU/g in retailers. From a statistical point of view, there are significant differences between the sampled sites (p-value = 0.04).

Mokhtari *et al.,* [30], found that fermented wheat harbours various microorganisms, including lactic acid bacteria, yeasts and filamentous fungi. However, the composition and diversity of the fermented wheat microbiota depended on the environment and the adaptation of microorganisms to fermentation conditions. Most of these fermentations involve a phase dominated by lactic acid bacteria, which may be associated with another stage of alcoholic fermentation by yeasts [31].

Achouke [25], observed in these experiments that none of the samples were contaminated with staphylococcus bacteria. Contamination would mainly occur as a result of non-compliance with hygiene rules, but also due to the unsanitary conditions of the sales environment.

III.1.5. Yeast and Mould Bacterial Loads

The results obtained from counting the yeast and mould in bread samples from different sampling sites are presented in table 5.

Table 5: Bacterial load (CFU/g) of yeast and mould from bread samples from different sites

Standort	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Bakery 1	12,46.10^2	0	2,30.10^2	4,67.10^2	6,05.10^2
Retailer 11	3,45.10^4	0	3,52.10^2	22,05.10^2	6,82.10^2
Retailer 12	20,59.10^2	22,55.10^3	3,14.10^2	4,91.10^2	6,32.10^2
Bakery 2	0	2,55.10^2	6,24.10^2	1,90.10^2	4,33.10^2
Retailer 21	25,52.10^2	27,59.10^2	7,64.10^2	4,43.10^2	16,59.10^2
Retailer 22	4,68.10^2	10,73.10^2	12,68.10^2	6,36.10^2	11,29.10^2
Bakery 3	2,05.10^2	94,92.10^4	0	4,59.10^2	5.10^2
Retailer 31	5,55.10^2	43,46.10^5	0	7,05.10^2	13.10^2
Retailer 32	7.10^2	36,86.10^5	0	6,76.10^2	10,14.10^2
Bakery 4	24,64.10^2	5,86.10^2	8,38.10^2	5,14.10^2	10,09.10^2
Retailer 41	39.10^3	59,67.10^4	27,23.10^2	27,91.10^3	25,86.10^2
Retailer 42	68,18.10^2	48,71.10^2	29,57.10^2	5,33.10^2	16,82.10^2
Bakery 5	1,60.10^2	0	2,60.10^2	4,23.10^2	2,30.10^2
Retailer 51	2,70.10^2	9,86.10^2	1,80.10^2	6,82.10^2	5,64.10^2
Retailer 52	16,14.10^2	1,90.10^2	0	2,50.10^2	8,62.10^2

The results in table 5 show that samples from retailers 11, 31, 41, and 42 contain significantly more yeast and mould than samples from other sites. The bacterial load ranges from 0 to 43.46 × 10^5 CFU/g.

Barmati *et al.,* [27], observed that when fungi were cultivated from fermented wheat flour and bread flour on Sabouraud media, moulds were characterised by a filamentous appearance and yeasts were represented by smooth colonies. These results were due to storage conditions involving temperature and water infiltration, but these microorganisms are also involved in the spontaneous fermentation of cereals [32].

Achouke [25], found that all samples of Kandji bread were heavily contaminated with yeast (3.2 × 10^2 and 15 × 10^2 CFU/g), while the same samples were lightly contaminated with mould (3 and 11 CFU/g). The presence of these germs could be explained by the high sugar content in the samples.

Abellana *et al.*,[33], observed high levels of mould contamination among retailers, unlike in bakeries. Vagelas *et al.,* [34], showed that mould growing on 1 to 5 % of bread produced results in changes in colour and taste and a loss of quality generally linked to high mycotoxin production.

When comparing our results with those of Umba *et al.,* [8], these authors found low bacterial loads of staphylococci with an average of 8 CFU/g. This is lower than the results found in the present study. The difference may be due to the hygiene practices of the various individuals handling the bread samples after they came out of the oven.

Compared to Salimata *et al.,* [7], the rates of bread contamination by yeasts and moulds were 22.6 % at the bakery, 27.9 % at the point of sale and 30.64 % at distributors, which are far higher than those obtained in this study. In addition, the same authors indicated that bread contamination can occur during cooling, transport and storage.

III.2. Assessment of the Hygienic Quality of Bread Samples Analysed

Table 6 provides an overall assessment of the microbiological quality of bread samples analysed from different sampling sites.

Table 6: Assessment of the hygienic quality of different bread samples analysed

Standort	FMAT					Enterobacteria					Salmonella					Staphylococci					Yeasts and moulds				
	E_1	E_2	E_3	E_4	E_5	E_1	E_2	E_3	E_4	E_5	E_1	E_2	E_3	E_4	E_5	E_1	E_2	E_3	E_4	E_5	E_1	E_2	E_3	E_4	E_5
Bakery 1	A	S	S	S	S	NS	S	S	S	S	NS	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Retailer 11	NS	S	S	A	S	NS	S	S	NS	S	NS	S	S	S	NS	S	S	S	S	S	A	S	S	S	S
Retailer 12	NS	A	NS	S	S	S	S	S	S	S	NS	S	NS	S	S	S	S	S	S	S	S	A	S	S	S
Bakery 2	S	S	S	S	S	S	S	NS	S	S	S	S	S	S	S	S	A	S	S	A	S	S	S	S	S
Retailer 21	S	S	S	S	S	S	NS	S	S	S	S	S	S	S	S	S	A	S	S	S	S	S	S	S	S
Retailer 22	S	S	S	S	S	S	NS	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Bakery 3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	S	S	S	S	S	NS	S	S	S
Retailer 31	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	A	S	S	S	S	S	NS	S	S	S
Retailer 32	S	S	S	S	S	S	S	S	S	S	NS	S	S	S	S	A	S	S	S	S	S	NS	S	S	S
Bakery 4	A	S	S	S	A	NS	S	S	S	S	S	S	S	S	S	A	A	A	S	A	S	S	S	S	S
Retailer 41	A	S	A	A	A	S	S	NS	S	NS	S	S	S	S	S	A	A	A	S	A	A	NS	S	A	S
Retailer 42	A	A	A	NS	A	S	S	S	S	S	S	S	S	S	S	A	S	A	S	A	S	S	S	S	S
Bakery 5	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Retailer 51	S	S	S	S	A	S	S	S	NS	NS	NS	S	S	S	S	S	NS	S	S	A	S	S	S	S	S
Retailer 52	S	A	S	S	A	NS	S	S	S	S	NS	S	S	S	S	S	NS	S	S	A	S	S	S	S	S

Key : (S) : Satisfactory, (A) : Acceptable, (NS) : Not satisfactory, (E) : Sample, FMAT : Total aerobic mesophilic flora

The results in table 6 show that of the 75 samples analysed, 2, 4, 8 and 12 samples were unsatisfactory for staphylococci, mesophilic aerobic bacteria, salmonella and enterobacteria, representing 2.67 %, 5.33 %, 10.67 and 16 % respectively of the non-compliance rate. However, 16 and 19 samples analysed, representing 21.33 % and 25.33 % respectively, are acceptable for mesophilic aerobic bacteria and staphylococci; the remaining samples are of good bacteriological quality.

The presence of unsatisfactory and acceptable yeasts and moulds was detected in 4 samples, while 67 samples analysed were satisfactory, representing 5.33 % and 89.33 % respectively.

From a hygiene perspective, only bread from bakery 5 complies with standards. However, the bread sold and consumed by the population of Kisangani is unfit for consumption because it does not meet food hygiene standards. The presence of detected germs, such as enterobacteria, salmonella and staphylococci, makes the food unfit for consumption because the identified germs are already a danger. In addition to the fact that these germs can gradually become pathogenic, their massive presence is sufficient cause for the rejection of the food that contains them.

Salimata *et al.,* [7], working on the assessment of the microbiological and chemical quality of bread in Bamako bakeries, found that 24 of the 31 samples analysed did not comply with FMAT standards, i.e. 77.4 %. However, yeast was detected in 7 samples, representing 22.6 % non-compliance at the bakery level. Furthermore, at the distributor level, FMATs were found in 96.8 % of samples, yeasts were detected at rates above the standard, i.e. 30.64 %, while staphylococci, enterobacteria and salmonella were not found in bread samples at the distributor level. At points of sale, mesophilic bacteria were found in 98.9 % of samples and yeasts in 27.9 %.

This difference is thought to be due to a failure to comply with basic food hygiene principles (unsanitary preparation and sales areas).

Furthermore, Achouke [25], showed that samples of Kandji bread were contaminated by various microorganisms to varying degrees. The highest levels of FMAT contamination were observed in samples k2 and k7 (4.1×10^7 CFU/g and 3.1×10^7 CFU/g) respectively. All samples were contaminated with total coliforms. Staphylococci and yeasts were also found in all samples (except k4 for staphylococci), and none of the samples were contaminated with salmonella.

CONCLUSION

The objective of this study was to evaluate the microbiological and hygienic quality of bread sold and consumed in the city of Kisangani. Thus, the isolation and enumeration of germs were carried out using the serial decimal dilution technique and the hygienic quality was assessed according to Codex Alimentarius standards.

The results obtained showed that high bacterial loads of germs were found in retailers 11, 12, 21, 31 and 51. However, bread from four bakeries and retailers is unfit for consumption because it does not meet food hygiene standards. Hygiene measures are therefore necessary to improve quality.

REFERENCES

1. Volatier, Z., 2013 : The consideration of bread in nutritional and health risk assessment Directorate for Nutritional and Health Risk Assessment, French Food Safety Agency, 38 p.
2. Zubiria, L., 2021 : Oyster mushroom. Available https://www.paseporysante.net

3. Kone, B., 2017 : Microbiological study of drinking water in Dioro : Relationship between malnutrition and *Escherichia coli* carriage through drinking water consumption. Doctoral thesis, University of Science, Technology and Technology of Bamako, 121 p.
4. Anssa, 2014 : Report on the evaluation of the sanitary quality of bread consumed in Bamako, 48 p.
5. Medrzycki, P., Tosi, S., Gallina, A., Serra, G., Sgolastra, F., Renzi, M., Bortolotti, L., Lodesani, M., Mutinelli, F., Porrini, C., 2013 : Protein content and pesticide contamination of bee bread in the Italian monitoring project (BEENET). Food Quality International Congrès, Bologna 12-20.
6. FAO, 2007 : Expert Committee on Food Additives. Meeting, & World Health Organization. Evaluation of certain food additives and contaminants : sixty-eighth report of the Joint
7. Salimata, K., Mamadou, S., Mahmoud, A., Oumou, S., Abdoulaye, Z., Alassane, M., Safiatou, S., Madou, C., Cheick, T., Fatoumata, M., and Ousmane, T., 2020: Evaluation of the microbiological and chemical quality of bread and flour used to make bread in bakeries in Bamako, Vol. 01 No. 23, Malian Journal of Science and Technology – ISSN, 987-1031 pp.
8. Umba, J., Masimango, T., Kashala, J., Kusika, C. and Musay, P., 2018 : Analysis of the microbiological quality of bread sold and consumed as is in Kinshasa (DR Congo). Journal of Animal & Plant Sciences. Vol. 38, Issue 2 : 6244–6256.
9. Van Doorn, J., Mende, M., Noble, S., Hulland, J., Ostrom, A., Grewal, D. and Petersen, J., 2017 : Domo arigato mr. Roboto : Emergence of automated social presence in organizational frontlines and customers' service experiences. Journal of Service Research, 20(1), 43–58. https://doi.org/10.1177/1094670516679272
10. CUQ, 2007 : Food Microbiology, Department of Food Industry Science and Technology, University of Montpellier 2, 134 p.
11. Zayukua, 2004 : Microbiological analysis of chicken, horse mackerel and salted fish sold in Kinshasa with a view to raising awareness of the HACCP method, unpublished final dissertation.
12. Ipungu, 2002 : Contribution to the hygienic study of food consumed in Kinshasa : research into microorganisms in certain types of horse mackerel commonly known as "Mpiodi". Unpublished final dissertation.
13. Bogaert, J., Beeckman, H., De Cannière, C., Defourny, P., and Ponette, Q., 2020: The Forests of the Tshopo: Ecology, History and Composition. University presses of Liege, Agronomy Gembloux, 348 pp.
14. Basandja, L., 2025 : Local water governance and control of diarrhoeal diseases in the coverage area of the national clean schools and villages programme in Tshopo Province, Democratic Republic of Congo. Doctoral thesis, University of Kisangani, Faculty of Medicine and Pharmacy, 136 p.
15. Nshimba, S., 2008 : Floristic, ecological and phytosociological studies of the forests of Mbiye Island in Kisangani, DR Congo. Thesis, Free University of Brussels, 272p.
16. Ebwa, K., 2024 : Effects of African mosaic virus on the bromatological value of the leaves of five varieties of cassava (*Manihot esculenta* Crantz) grown in Kisangani.
17. Adheka, G., 2014 : Characterization and classification of the Congo basin African plantains (*Musa* AAB) in Democratic Republic of Congo. Thesis, University of Kisangani, 119 p.
18. Martial, G., 2016 : Assessment of the microbiological quality of "Tchachanga", braised mutton sold at the Bohicon and Hilla-Condji bus stations, End-of-training internship report, University of Abomey-Calavi, 54 p.
19. Delarras, C., 2007 : Practical Microbiology for Analysis and Health Control Laboratories. Editions TEC ❀ DOC, Lavoisier Paris, 476 p.
20. Mohammed, A., 2021 : Evaluation of the microbiological and physicochemical quality of flour produced by various mills in the province of Oum el Bouaghi, Thesis, Faculty of Exact Sciences and Natural and Life Sciences, Larbi Ben Mhidi University, Oum El Bouaghi, 46 p.
21. Mutsch, L., 2018 : Microbiological criteria applicable to foodstuffs : Guidelines for interpretation. Food Safety Division, Government of the Grand Duchy of Luxembourg, Thomas Edison, 57 p.
22. Guiraud, J. and Rosec, P., 2004 : Practical application of standards in food microbiology. Dunod, Paris, 615 p.
23. Ennadir, J., Hassikou, R., Ohmani, F., Hammamouchi, J., Bouazza, F., Qasmaoui, A., Mennane, Z., Ouazzani, T., Charof, R. and Khedid, K., 2012 : Microbiological quality of wheat flour consumed in Morocco. Canadian Microbiology Review, 58.
24. Guirand, J., 2003 : Food Microbiology. Agri-Food Series, 696 p.
25. Achouke, W., 2018 : Production technology and microbiological quality of "kandji" corn bread sold in Pahou (southern Benin), 22 p.
26. Benbrahim, M., 2013 : Microbiological quality of pastry products sold in Fez, Final Year Project, Faculty of Science and Technology, Sidi Mohamed Ben Abdellah University, 49 p.
27. Barmati, C., Derraoui, C. and Saioualdih, M., 2021 : Study of the nutritional and sensory quality of bread produced from a mixture of soft wheat flour and durum wheat fermented using the traditional method. Unpublished thesis, IBN Khaldoun University – Tiaret, Faculty of Natural and Life Sciences, 65 p.

28. Bationo, F., 2018 : African fermented cereal foods : another way to help meet folate requirements. Doctoral thesis, University of Montpellier, 289 p.
29. Secke, S., 2007 : Contribution to the study of the bacteriological quality of food sold on the streets of Dakar, Thesis, Cheikh Anta Diop University of Dakar, 42 p.
30. Mokhtari, S., Kheroua, O. and Saidi, D., 2016 : Isolation and identification of lactic acid bacteria from Algerian durum wheat (*Triticum durum*) natural fermented in underground silos matmora "El hammoum" and their antimicrobial activity again pathogenic germs. J Nutr Health Sci 3 (4): 403. Doi: 10.15744/2393-9060.3.403
31. Guyot, J., 2010 : Fermented Cereal Products. In Fermented foods and beverages of the world, CRC Press/Taylor & Francis, Boca Raton, USA, 448 p.
32. Kumari S., Guleria P. and Dangi N., 2015 : Cereal Based Beverages and Fermented Food : AReview. *International Journal of Enhanced Research in Science, Technology and Engineering*, 4 : 2319-7463.
33. Abellana, M., Torres, V., Sanchis, J., and Ramos, A., 1997: Characterization of various industrial baked goods. II. Study of the microbial flora. Alimentaria, 287: 51–56.
34. Vagelas, I., Gougoulias, N., Nedesca, E. and Liviu, G., 2011: Bread contamination withfungus. Carpathian Journal of Food Science and Technology, 3(2), pp. 1-6.