

Microbial contamination of the bread samples sold in Nigeria

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Abstract

Background and objective: Bakery products are of cereal group and considered as valuable nutritional source in human diet. They provide most of our daily calories. Development of bakeries' establishment is related to local financial capacity and processing techniques. It has led to different types of bread in term of their quality and hygienic status. Same as other countries, bread is staple food in Nigeria. In this study, we aimed to determine microbial contamination of the bread samples prepared and distributed in Wukari, a local government area in Taraba State, Nigeria.

Materials and methods: In this study, two types of bread were purchased from five different places in Wukari metropolis. Two retail bakeries were selected for sampling in each place. Analysis was done in microbiology laboratory of the Federal University Wukari. The samples were studied for *Bacillus subtilis*, *Staphylococcus aureus*, other *Staphylococcus* spp., *Streptococcus* spp., *Streptomyces* spp., *Aspergillus flavus*, and *Aspergillus niger* contamination to investigate the quality of practices during production and distribution.

Results and conclusion: Microbial contamination of the bread samples was included to *Bacillus subtilis* 22.5%, *Aspergillus flavus* 20%, *Aspergillus niger* 17.5%, *Streptomyces* spp. 12.5%, *Streptococcus* spp. 12.5%, *Staphylococcus aureus* 7.5%, and other *Staphylococcus* spp. 7.5%. Our investigation revealed that a variety of bacteria and fungi species were present in the bread samples produced and distributed in Wukari, that make the products susceptible to rapid deterioration, and may lead to organoleptic changes and economic loss. Apparently, there is a need for strict surveillance and monitoring in the retail bakeries located in Wukari, Taraba State, Nigeria.

Keywords: Bacteria, bread, fungi, hygienic practices

1. Introduction

Food poisoning/infection is of major health problems associated with daily diet [1]. It occurs by

ingestion of microorganisms and/or their toxins present in the foods. Food-borne diseases significantly affect the global economy [2]. On the

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other hand, the increased multidrug resistance of the microorganisms originated from the foods makes the global economy vulnerable in tackling the food safety issues [3]. Therefore, development of hygienic practices in production units to assure safety of foods is of concern globally [1]. Emergence of new health issues in parallel to production of new products, developed processing and handling of foods, change of food habits, and availability of convenience foods has become a serious concern in food industry [1]. Although, the consumers' attention to labelling, production time, and freshness of foods decreases the rate of food-borne health issues to some extent [4]. Indeed, the information provided by the suppliers on labelling of the packages assures acceptable quality of the packed foods [5]. However, such informing programs are still underdeveloped in Nigeria and the consumers worry about mis-handling or improper processing of foods such as bakeries and demand a safer food supply. In this regard, the World Health Organization has introduced five keys to prepare a safe food [6]. Bread is a staple food prepared by a mixture of flour, water, sugar, salt, and yeast. Rich bread (sweet roll) is produced by addition of baking powder, sugar, egg, and milk/flavouring to flour, while yeast bread is prepared by a mixture of flour, fat, liquid, yeast, milk, and salt [7]. Yeast bread is more popular in Nigeria [8]. More than 20 billion pounds (9 billion kg) of bread is produced in the world annually [9]. A national survey revealed that consumption of bread has increased in recent years in Nigeria. There is an increasing tendency to snack foods such as different types of bread and biscuits among Nigerian children and adults [8]. Other than its taste and nutritional value, bread is popular among urban and rural consumers because it is available and easily prepared for eating [10,11]. However, its processing, storage, and handling are matter of concern and may put the consumers at risk of food-borne disease [10]. Approximately, food borne diseases cause one-third of deaths worldwide [4]. The widespread

occurrence of *Staphylococcus* infection is a result of unhygienic practices done by the workers and the handlers in food preparation places [6]. Importantly, some health-threatening microorganisms may grow and multiply in foods without changing the appearance of the product [12,13]. Use of contaminated raw materials, inadequate cooking, reheating of cooked foods obtained from unsafe sources, and long time between cooking/heating and consumption may increase the risk of food contamination and food poisoning [14]. Consumption of contaminated bread (as a highly consumed food) can cause serious health issues in human. Therefore, this work was carried out to examine the presence of some bacteria and fungi in the bread prepared and distributed in Wukari (Taraba State, Nigeria) and evaluate their safety for consumption of the inhabitants.

2. Materials and methods

2.1. Materials

Plate Count Agar (PCA), and Potato Dextrose Agar (PDA), and Nutrient Agar (NA) were purchased from HiMedia company (USA).

2.2. Study design

The study was done between January and March 2022. Two types of bread were purchased from five different places in Wukari metropolis (Taraba State, Nigeria). Two retail bakeries were selected for sampling in each location. The samples were placed in sterile polythene bags and transferred to the microbiology laboratory of Federal University Wukari for analysis.

2.3. Microbial Analysis

2.3.1. Preliminary microbial study

One gram of bread was mixed with 9 ml of distilled water. The mixture was diluted ten-fold up to 1:10000 (10^{-4}) dilution. Then, 1 ml of each aliquot was aseptically transferred to the bottom of PCA and PDA plates separately in triplicate. Bacterial enumeration was done after incubation of PCA at 37 °C for 24 h and fungal study was carried out after incubation of PDA at 25 °C for 6

days. For bacteria, the colonies were firstly investigated visually. Then, they were studied by gram staining and biochemical tests of catalase, coagulase, and sugar fermentation (i.e., able to ferment lactose, sucrose, maltose, mannitol, and fructose). Fungi were investigated structurally by microscope [15].

2.3.2 Microbial isolation

For isolation of fungi, PDA plates were inoculated with 0.1 ml of 10^{-2} dilution by streaking method and incubated at 25 °C for 48 h. Similar method was used for bacterial isolation in NA and the inoculated plates were incubated at 37 °C for 48 h. Then, the distinct pure colonies were picked up and inoculated to slant NA and PDA. They were incubated again under the conditions mentioned above. Colonies of bacteria

were studied by gram staining, motility test, spore staining, capsule staining, catalase test, oxidase test, starch hydrolysis, citrate utilization, oxygen relationship, and sugar fermentation. Colonies of fungi were studied microscopically and reproductive and vegetative structures were investigated. Spores, sporangia, hyphae, and septa were studied during microscopy [15].

3. Results and discussion

Table 1 shows the results of microbial isolation from the samples. Accordingly, *Bacillus subtilis* was the most abundant microorganism (22.5%) followed by *Aspergillus flavus* (20%), *Aspergillus niger* (17.5%), *Streptococcus* spp. (12.5%), *Streptomyces* spp. (12.5%), *Staphylococcus aureus* (7.5%), and *Staphylococcus* spp. (7.5%).

Table 1- Microbial assessment of the bread samples collected from the retail bakeries in Wukari

Organism		Sample sources	Positive isolates (n)	Positive isolates (%)
Bacteria	<i>Streptococcus</i> spp.	2	10	12.5
	<i>Streptomyces</i> spp.	2	10	12.5
	<i>Bacillus subtilis</i>	4	18	22.5
	<i>Staphylococcus aureus</i>	2	6	7.5
	<i>Staphylococcus</i> spp.	2	6	7.5
Fungi	<i>Aspergillus flavus</i>	4	16	20.0
	<i>Aspergillus niger</i>	4	14	17.5
Total		20	80	100

Tables 2 and 3 represent the occurrence of fungal and bacterial isolates in each bread sample. In total, 40 isolates of both fungi and bacteria were achieved for each bread. As seen in Table 2, occurrence of *Aspergillus niger* and *Aspergillus flavus* in bread A was accounted as 36% and 64%, respectively. In comparison, 56% and 44% of the fungal isolates in bread B were *Aspergillus niger* and *Aspergillus flavus*, respectively.

According to Table 3, *Bacillus subtilis* was the most abundant bacterium in both types of Bread. Isolates of *Streptococcus* spp., *Staphylococcus* spp., and *Streptomyces* spp. in bread A were 19%,

27%, and 23% of total contamination, respectively. For Bread B, isolates of *Streptococcus* spp., *Staphylococcus* spp., and *Streptomyces* spp. were 21%, 21%, and 16% of total contamination, respectively.

Table 2- Occurrence of fungi in the bread samples collected from the retail bakeries in Wukari

	Isolate	
	<i>Aspergillus flavus</i> n (%)	<i>Aspergillus niger</i> n (%)
Bread A	9 (64)	5 (36)
Bread B	7 (44)	9 (56)

Table 3- Occurrence of bacteria in the bread samples collected from the retail bakeries in Wukari

	<i>Streptococcus</i> spp. n (%)	<i>Bacillus subtilis</i> n (%)	<i>Staphylococcus</i> spp. n (%)	<i>Streptomyces</i> spp. n (%)
Bread A	5 (19)	8 (31)	7 (27)	6 (23)
Bread B	5 (21)	10 (42)	5 (21)	4 (16)

Bread is of perishable foods because it contains all the nutrients necessary for microbial growth and metabolism. Common food microorganisms such as *Aspergillus* and *Bacillus* species can survive in the matrix and make the product inappropriate for human consumption. Therefore, it is important to assure hygienic processing in order to avoid food infection and poisoning after consumption of the product [10,11].

In the current study, the isolated and identified microorganisms are etiology of some diseases. It corroborates previous findings that reported food borne diseases are widespread in the contemporary world and responsible for about one-third of deaths in the globe [16]. Our results are in agreement with another study in which *Staphylococcus* spp., *Bacillus* spp., and *Saccharomyces cerevisiae* were isolated from bread samples in Bori Metropolis (River States, Nigeria). Importantly, staphylococcal contamination is common in food chain because staphylococcus species are of normal flora of animals and humans and may transfer from the handlers and the animals present in the food preparation area to the foods [4]. Thus, unhygienic practices in bread production should be controlled appropriately. For example, bread vendors and hawkers may contaminate the equipment used in the bakeries and point of distribution through which the contaminants enter the bread [1,16].

4. Conclusion

Bread is rich of carbohydrate as a main source of energy. It also is a fuel for the brain, the kidneys, heart muscles, and central nervous system. Results of our study showed that the bread samples distributed in Wukari local government area of Taraba state were contaminated by a variety of bacteria and fungi species. Such contamination is a major safety concern for

human health and may put the population at risk of food-borne diseases. In addition, it shows poor hygienic practices made by the handlers. Indeed, inadequate washing of the hands is of major sources of contamination in food chain. In this regard, the vendors and the consumers are advised to handle bread hygienically and purchase bread from the approved places equipped with appropriate processing and packaging equipment. Development of Good Hygienic Practice (GHP) and Hazard Analysis and Critical Control Point (HACCP) principles in place reduces the chance of contamination in bread.

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6. Conflict of interests

The authors declare no competing interest.

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