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PROBING THE BACTERIAL CONTAMINATION OF STREET VENDED FOODS IN THE CALABAR METROPOLIS THROUGH CONVENTIONAL MICROBIAL TECHNIQUES

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Abstract

Street foods are points at which ready-to-eat foods are sold on public roads. However, the handling and sales of food used in these trades can pose risks to public health. **Aim:** This study evaluated the bacterial quality of ready-to-eat snacks vended in the Calabar Metropolis. **Methods**: Thirteen (13) samples were obtained from different locations in the Calabar Metropolis. Standard microbial techniques were used for analysing the collected samples. **Results:** This study revealed that the total heterotrophic bacteria and total coliform count (THBC) ranged from 1.1 × 104 cfu/g to 9.6 × 105 cfu/g, while the total coliform count (TCC) ranged from 1.2 × 10^2 cfu/g to 5.8 × 104 cfu/g. The bacteria identified and their prevalence included *E. coli* (n=5, % =38), *S. aureus* (n=4, %=31), *Bacillus* spp. (n=3, %=23) and *Pseudomonas* sp. (n=1, %=8). The main inadequacies were related to the hygienic conditions of the sellers. The results indicated that some samples were contaminated, indicating nonenforcement of regulatory acts and food safety procedures to Hazard Analysis Critical Control Point (HACCP) and Good Manufacturing Practices (GMPs). **Conclusion:** Street vending is still a potential source of pathogens that cause foodborne illnesses.

Keywords: Bacterial analysis, ready-to-eat, microbial analysis, bacterial count, foodborne diseases

1.0 Introduction

Street vended food is characterized as food or drinks sold on streets and consumed without any further preparation. These trades have adept consumers in all regions of the world and are selling more than just meals, revealing aspects of the local culture and gastronomy of different locations (Abrahale *et al*., 2019). It is estimated that approximately 2.5 million people consume food in these trades daily (Kothe *et al*., 2016). Selling food on the streets has benefits for sellers and consumers: people start marking food as a source of income that helps the home economy. In other cases, it contributes to the survival of families facing financial difficulties (Abrahale *et al.*, 2019). For consumers, elements such as practicality, accessibility, variety of options, appreciable palatability, and affordable price are attractive, considering the moment of choice for this kind of meal (Asiegbu *et al.*, 2016).

In many of these street food trades, production and sale conditions include empirical handling practices, poor hygiene practices, inadequate infrastructure and a lack of potable water points (Amare *et al.,* 2019). Therefore, street foods cause great concern among agencies involved in food safety (Trafialek *et al*., 2017). Snacks are generally associated with foodborne illnesses and are known to be an important global public health problem (Asiegbu *et al.,* 2016). In addition, this is strongly associated with the lack of hygienic and sanitary control in food production processes, such as hand hygiene and handling (Abrahale *et al.*, 2019). "Snacks" means something eaten between mealtimes. Most snacks are sold on roads and at schools and colleges. In snacks, different foods, such as fruit juice, plantain chips, and egg rolls, are included. The trend of consuming snack food increases daily. These snacks are common sources of foodborne diseases and lack nutritional value. The increasing trend of snack consumption in various countries has caused nutritional problems (Dahraj *et al*., 2023).

In the Calabar metropolis, there have been cases of food poisoning and foodborne disease. This has been a great threat to the lives of many people, pushing them to spend large sums of money on treatment. For instance, the researcher had often heard and seen many cases of foodborne disease in Calabar Metropolis. Some of these victims did not have enough money to afford their treatment bills. As a result, many lives have been lost. If this continues, it would not be surprising if a chronic disease outbreak occurred in the area that may have resulted from poorly manged meals. Therefore, it is paramount to ascertain the safety of foods in the Calabar metropolis. This would provide insight into the level of microbial contamination with regard to food. The present study bacteriologically analysed street vended foods sold in the Calabar metropolis.

2.0 Methodology

2.1 Materials

The glassware and equipment used for this research included Petri dishes, glass slides, test tubes, a measuring cylinder, a syringe, beakers, a conical flask, an incubator, a refrigerator, a pressure pot, a Bunsen burner, a wire loop, a test-tube rack, stock bottles, a microscope, masking tape, foil paper, a plastic bag, ice pack cotton wool, a methylated spirit, a mortar and a pestle.

2.2 Method

2.2.1 Sample collection and preparation

The samples were collected from vendors selling in the Calabar Metropolis. Thirteen (13) samples were obtained from different locations around the area. The samples were collected through random sampling of food by using sterile disposable tongs as outlined in the process hygiene criteria of Regulation EC 2073/2005 (European Commission, 2005). The samples were wrapped in sterile aluminum foil to prevent contamination and transported to Microbiology Laboratory, University of Cross River State (UNICROSS), Calabar, for culture. Thereafter, ten grams (10 g) of each of the snack samples were carefully and aseptically weighed, uniformly homogenized in a mortar and added to 90 ml of distilled water to make a stock solution. Later, a 10-fold serial dilution was carried out, and 0.1 ml was plated from dilutions 10^{-4} and 10^{-6} in duplicate on nutrient agar and MacConkey agar by the pour plate method and incubated at 37°C for 24 hours.

2.2.2 Determination of the bacterial count

After the plates were incubated, the growth, number of colonies, morphology, and consistency of the isolates were examined, and the colony size was also measured. The discrete colonies were picked and subcultured on a nutrient agar slant and incubated at 37°C for 24 hours. The sample was then refrigerated for further verification and confirmation via biochemical tests.

2.2.3 Biochemical tests

The procedures adopted for Gram staining and other biochemical tests, as described by previous researchers, including Agurokpon and Agbiji (2024), were followed appropriately. The biochemical tests included the indole test, citrate test, Voges–Proskauer (VP) test, methyl red (MR) test, motility test (hanging drop technique), catalase test, and coagulase test.

3.0 Results

3.1 Total heterotrophic bacterial (THBC) and total coliform (TC) counts

Table 1 shows the THBCs and TCCs obtained from the snack samples. The results revealed snack samples from various vendors within the Cross River University of Technology, Calabar campus. The total heterotrophic bacterial count ranged between 1.9x105 cfu/g and 9.6x105 cfu/g. The total coliform concentration ranged from 1.25x103 cfu/g to 7.2x103 cfu/g.

3.2 Morphological and biochemical characterization of bacterial isolates

Table 2 below shows the morphological and biochemical characterization of the bacterial isolates and the probable organisms found in the snack samples that were analysed in the laboratory.

4.3 Percentage frequency of bacterial isolates

Figure 1 shows the percentages of the bacterial isolates. *E. coli* had the highest frequency of occurrence (38%), followed by *Staphylococcus aureus* (31%), *Bacillus* species (23%), and *Pseudomonas* species (8%).

Table 1: **Total heterotrophic bacteria and total coliform count (cfu/g)**

Sample number	Total Heterotrophic Count (THBC)	Total Coliform Count (TCC)
1	9.6×10^5	6.0×10^3
2	1.1×10^4	5.2×10^3
3	3.8×10^5	4.6×10^3
4	0.4×10^5	1.5×10^4
5	1.9×10^4	2.1×10^4
6	2.0×10^4	5.8×10^4
7	1.2×10^5	6.8×10^3
8	8.4×10^5	6.6×10^3
9	4.5×10^4	3.3×10^3
10	3.4×10^5	1.2×10^3
11	1.7×10^5	2.3×10^3
12	1.3×10^5	1.2×10^3
13	1.5×10^5	1.7×10^2

Table 2: Morphological and biochemical characteristics of bacterial isolates

Isolates	**Colour**	**Gram**	**Shape**	**Catalase**	**MR**	**VP**	**Indole**	**Citrate**	**Motility**	**Probable Organism**
SPL_1	White	+	Cocci	+	+	+	-	+	-	*Staphylococcus aureus*
SPL_2	Creamy	+	Rod	+	-	+	-	+	+	*Bacillus* spp.
SPL_3	White	-	Rod	+	+	-	+	_	+	*Escherichia coli*
SPL_4	Pink	+	Cocci	+	+	+	-	+	-	*Staphylococcus aureus*
SPL_5	White	-	Rod	+	+	-	+	-	+	*Escherichia coli*
SPL_6	Yellow	+	Cocci	+	+	+	-	+	-	*Staphylococcus aureus*
SPL_7	White	-	Rod	+	+	-	+	-	+	*Escherichia coli*
SPL_8	Pink	+	Cocci	+	+	+	-	+	_	*Staphylococcus aureus*
SPL_9	Greenish-blue	-	Rod	+	-	-	-	+	-	*Pseudomonas* spp.
SPL_10	White	-	Rod	+	+	-	+	-	+	*Escherichia coli*
SPL_11	Creamy	+	Rod	+	-	+	-	+	+	*Bacillus* spp.
SPL_12	White	-	Rod	+	+	-	+	-	+	*Escherichia coli*
SPL_13	Creamy	+	Rod	+	-	+	-	+	+	*Bacillus* app.

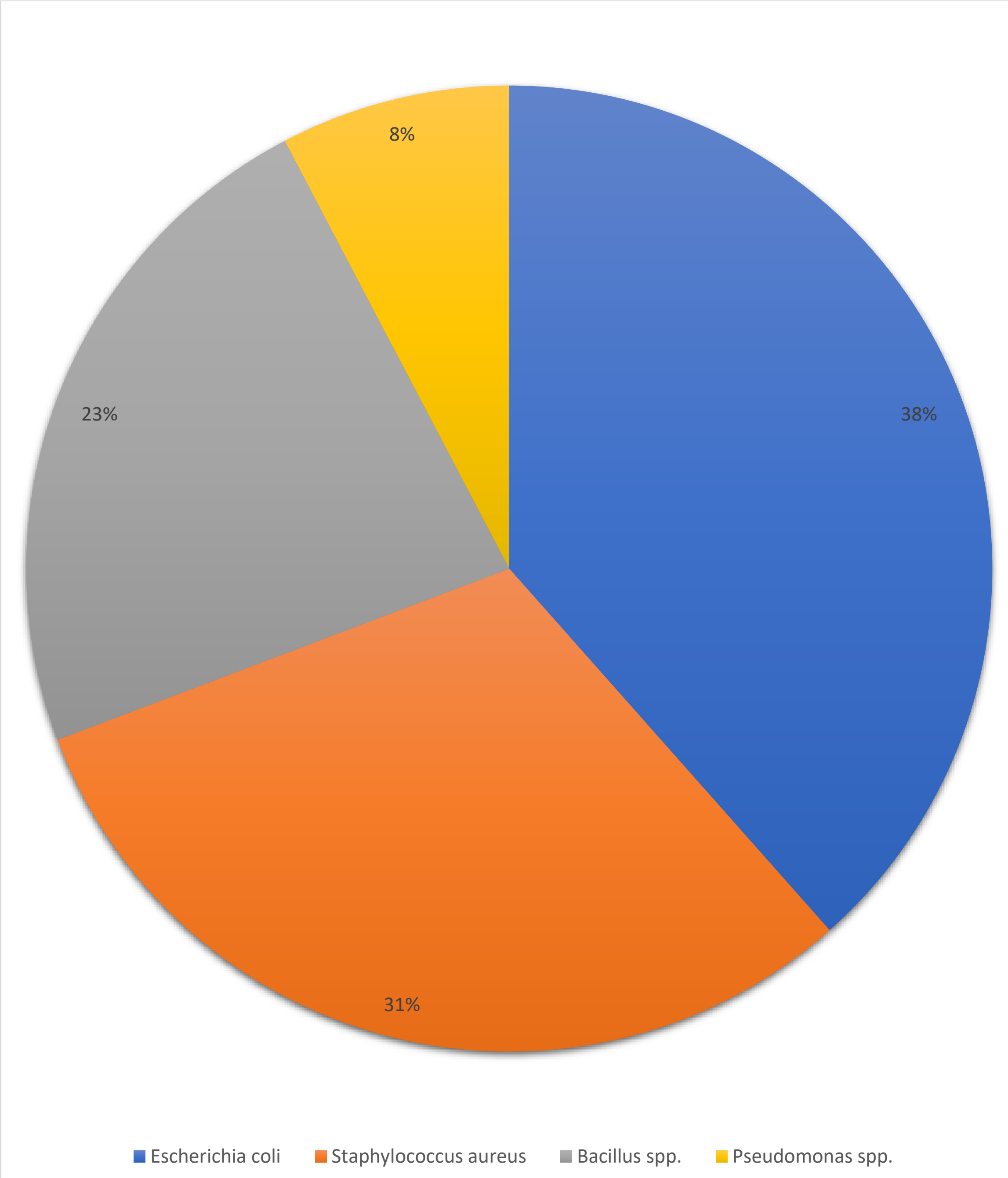

Figure 1: Percentage distribution of the bacterial isolates

4.0 Discussion

Microbial contamination of food is well documented. These fomites, in turn, serve as vehicles for cross-contamination and cross-infections; some can be highly pathogenic and can be transferred from one person or point to another or may result in autoinoculation. In this study, a total of 13 samples of street vended foods were collected from the vendors Calabar metropolis, Cross River State, Nigeria. The results indicated the presence of both gram-positive and gram-negative bacteria. One of the main reasons for the presence of these isolates is the lack of cleanliness in handling, inadequate processing, cross contamination of the raw materials and improper storage conditions (Das *et al*., 2010). The present study showed that *Escherichia coli* (*E. coli*) was the most prevalent organism (38.5%), followed by *Staphylococcus aureus* (30.8%) and *Bacillus* species (23.1%). Moreover, the bacterial load in food samples has been reported to be due to personal hygiene and unhygienic processing conditions (Amare, *et al*., 2019).

It is important to note that even small numbers of organisms, such as *S. aureus*, may proliferate and become hazardous if transferred to food. It was observed that appropriate hygiene conditions in terms of personal hygiene, good manufacturing and food safety practices were not followed by the producers or vendors in this investigation, hence the high bacterial load and presence of pathogenic organisms. The presence of these organisms can be linked to a number of factors, such as important handling and processing conditions by producers, water contamination during washing and processing, cross-contamination from raw materials used during production and the use of dirty processing utensils such as mixing bowls, knives and trays (Ike *et al.*, 2015).

According to Tomar and Akarka (2019), the microorganisms most commonly found in contaminated foods are *Enterobacter, E.* coli, *Salmonella* spp., and *S. aureus*. *Staphylococcus aureus* is a bacterium that inhabits the skin, hands, respiratory region and superficial wounds and is therefore an important indicator of hygiene behaviour. Studies have revealed the contamination of ready-to-eat foods by this microorganism. There is a high risk when this pathogen reaches counts greater than 10^5 in foods, resulting in the production of stable staphylococcus enterotoxins and serious health problems (Kothe *et al.*, 2016). *Escherichia coli* is considered an important enterobacterium. Its presence in food is used as an indicator of faecal contamination and low hygiene conditions in food handling, especially hand hygiene, cross-contamination through utensils, and contact between raw and ready-to-eat or ready-for-consumption materials. For that reason, it should not be present in ready-to-eat foods since its ingestion can cause diarrhea and dysentery (Shiningenni *et al.*, 2019).

5.0 Conclusion

E. coli had the highest percentage occurrence in the present study, and the presence of pathogenic *S. aureus and E. coli* in fast food is alarming. This study concluded that some foods vended in the Calabar metropolis are not wholesome for consumption. Therefore, to prevent foodborne diseases, safety measures that include, but are not limited to, good practices, proper handling, regular monitoring and effective awareness campaigns should be carried out to educate major players in the snack industry on food safety management, associated vending hazards and critical points to be monitored to increase consumers' confidence and safety in consumed snacks.

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