

MICROBIAL EVALUATION AND PROXIMATE ANALYSIS OF READY-TO-EAT ROADSIDE SNACKS IN ABRAKA AND AGBOR

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Abstract

This study investigates the microbial quality and proximate composition of commonly consumed ready-to-eat roadside snacks sold in Abraka and Agbor, two major urban centres in Delta State, Nigeria. A total of selected snack samples, such as roasted groundnuts, akara (bean cake), meat pie, puff-puff, and fried fish, were aseptically collected from different vendors in both locations. Microbial evaluation was carried out using standard microbiological procedures to determine total viable bacterial count, fungal count, and the presence of indicator and pathogenic organisms. Proximate analysis (moisture, ash, crude protein, crude fat, crude fibre, and carbohydrate content) was conducted using AOAC standard methods. Results revealed varying microbial loads among the samples, with some exceeding acceptable limits for ready-to-eat foods, particularly those exposed to dust, poor handling, and inadequate storage. Identified microorganisms included *Staphylococcus aureus*, *Escherichia coli*, *Bacillus spp.*, and assorted fungal species, indicating potential contamination from handling, environment, and processing equipment. Proximate composition also varied significantly among the snacks, reflecting differences in ingredients and preparation methods. Snacks with higher moisture content showed correspondingly higher microbial counts. The study underscores the public health implications of consuming poorly handled roadside foods and highlights the need for improved hygiene practices among vendors, regular monitoring by health authorities, and increased consumer awareness. It also provides baseline data useful for food safety assessment in Abraka, Agbor, and similar urban settings.

Introduction

Ready-to-eat (RTE) roadside snacks have become an essential part of daily nutrition for many individuals in Nigeria, particularly in rapidly growing urban centres such as Abraka and Agbor in Delta State. These foods, which include items such as akara, roasted groundnuts, meat pies, puff-puff, fried fish, buns, and roasted plantain, are valued for their affordability, convenience, and accessibility. Students, workers, traders, and commuters frequently depend on such snacks as quick meal alternatives due to increasing work schedules, long commuting hours, and limited time for home-prepared meals. As the demand for ready-to-eat foods continues to rise, street food vending has expanded, forming an important socio-economic activity in these communities.

Despite their nutritional and economic relevance, RTE roadside snacks are often associated with significant food safety challenges. Many of these foods are prepared, displayed, or sold in environments that may expose them to contamination. Factors such as poor personal hygiene among vendors, inadequate hand-washing practices, the use of contaminated water, improper storage, exposure to dust and flies, and the absence of sanitary food-handling facilities contribute to the proliferation of pathogenic microorganisms. Several studies across Nigeria and other developing countries have reported the presence of foodborne pathogens such as *Staphylococcus aureus*, *Escherichia coli*, *Salmonella* spp., *Bacillus* spp., and fungal contaminants in RTE roadside foods. Consumption of such contaminated foods may result in foodborne illnesses including diarrhoea, vomiting, fever, and in severe cases, life-threatening infections.

Another important aspect of food quality is the proximate composition, which describes the nutritional makeup of foods in terms of moisture, ash, crude protein, crude fat, crude fibre, and carbohydrate content. These parameters influence not only the nutritional value of the snacks but also

their shelf life and susceptibility to microbial spoilage. For instance, foods with high moisture content are more prone to rapid microbial growth, while fat-rich snacks may undergo oxidative rancidity if not properly handled. Variations in processing methods, ingredients, frying temperature, and storage conditions often result in differences in the proximate composition of roadside snacks sold across different locations.

Although roadside snacks are widely consumed in Abraka and Agbor, scientific data on their microbial safety and nutritional profile remain limited. Understanding the extent of microbial contamination and the proximate composition of these foods is crucial for public health planning, consumer awareness, and the development of food safety guidelines. Such information can also help vendors adopt safer food-handling practices and assist regulatory agencies in monitoring the quality of street-vended foods.

Therefore, this study focuses on the microbial evaluation and proximate analysis of selected ready-to-eat roadside snacks in Abraka and Agbor. The findings will provide valuable insights into the safety, nutritional quality, and potential health risks associated with the consumption of these commonly consumed snacks.

The Role of Ready-to-eat roadside snacks in Abraka and Agbor

Ready-to-eat roadside snacks play an important role in the everyday lives of people in Abraka and Agbor, serving not only as convenient food choices but also as vital components of the local economy and social life. In these rapidly growing towns, many residents including students, traders, civil servants, artisans, and travelers depend on street-vended snacks as quick and affordable sources of nourishment. The busy lifestyle associated with academic activities in Abraka, especially within the university community, and the commercial vibrancy of Agbor make roadside foods an essential part of daily feeding patterns. These snacks provide immediate access to food for people who have limited time to prepare meals at home or cannot afford to eat in formal restaurants.

Beyond their convenience, ready-to-eat snacks contribute significantly to urban food security. Many low-income households rely on these foods to meet their nutritional needs due to unstable incomes and rising food prices. Vendors provide meals throughout the day, ensuring that residents have continuous access to food in areas where alternative food outlets may be scarce or costly. The availability of snacks such as akara, buns, puff-puff, roasted plantain, roasted groundnuts, and meat pies helps bridge nutritional gaps for people who spend long hours outside the home.

The sale of roadside snacks also plays a major economic role in Abraka and Agbor. Many vendors particularly women and young people earn their livelihood from the preparation and sale of these foods. Their activities stimulate small-scale entrepreneurship and generate employment along the food chain, from the suppliers of raw materials to the marketers and assistants who help with sales. This steady flow of economic activity contributes to reducing unemployment and strengthening the informal sector within both towns.

Culturally, roadside snacks reflect the rich traditional food practices of the communities. Foods such as akara, moimoi, roasted fish, and “boli” (roasted plantain) carry cultural identity and serve as familiar, comforting meals to residents and visitors alike. Street-vending sites often become social spaces where people gather, interact, and build relationships, reinforcing community bonds.

Nutritionally, many ready-to-eat snacks contribute essential nutrients to the diet. Plant-based snacks like akara and moimoi provide protein, groundnuts supply healthy fats, and plantain-based snacks offer energy, fibre, and micronutrients. Although the nutritional content varies depending on preparation methods, these snacks often serve as practical supplements to daily dietary needs.

Overall, ready-to-eat roadside snacks in Abraka and Agbor play a multifaceted role by providing convenience, supporting food security, sustaining livelihoods, preserving cultural identity, and contributing to the nutritional needs of the population. Their popularity and significance highlight the need to better understand their microbial quality and nutritional composition, given their importance to public health and community life.

Methodology

The study was conducted in Abraka and Agbor, Delta State, focusing on roadside vendors and eateries that sell ready-to-eat snacks. Five commonly consumed snack types; meat pie, chicken pie, sausage roll, egg roll, and doughnut were collected from selected sites. Two replicate samples were obtained from each location at two-week intervals, transported under cold conditions, and analyzed within twelve hours to ensure sample integrity.

Microbiological analyses were carried out to assess bacterial and fungal contamination, including the detection of *Escherichia coli*. Standard culture media, serial dilution techniques, and incubation procedures were used. Bacterial isolates were further characterized through Gram staining and biochemical tests, while fungal isolates were identified using lactophenol cotton blue staining.

Proximate composition analyses determined moisture, protein, fat, and ash content using standard AOAC methods. All collected data were statistically analyzed using SPSS and Microsoft Excel to determine microbial loads, nutritional composition, and potential variations among snack types and locations. This methodology ensured a comprehensive assessment of both the microbiological safety and nutritional quality of ready-to-eat roadside snacks in the study areas.

Literature Review

Ready-to-eat (RTE) roadside snacks form an essential part of the informal food sector in many developing countries, including Nigeria, where they contribute to daily nutrition, convenience, and household food security. In rapidly growing towns such as Abraka and Agbor in Delta State, these snacks are widely consumed by students, workers, traders, and commuters due to their affordability and accessibility. However, extensive literature has shown that RTE roadside foods are frequently associated with microbial contamination and varying nutritional quality, raising important public-health concerns.

Several studies in Nigeria have reported high microbial loads in street-vended foods, often exceeding acceptable safety limits. According to Bryan et al. (1992), the major organisms implicated in foodborne diseases include *Escherichia coli*, *Staphylococcus aureus*, *Salmonella* spp., *Bacillus* spp., *Clostridium* spp., and various fungi and yeasts. Poor hygiene practices, inadequate hand washing, contaminated water, and exposure to dust and flies are significant contributors to microbial contamination in RTE foods (Bhowmik, 2010; Osakue et al., 2016). Similar findings were reported by Ackah et al. (2011), who noted that many street vendors in West Africa lack adequate knowledge of food handling, sanitation, and environmental hygiene, thereby increasing the likelihood of contamination.

Studies conducted in different parts of Nigeria have shown that snacks such as akara, buns, moimoi, roasted groundnuts, and meat pies frequently contain pathogenic bacteria when sold in open environments. Biswas et al. (2010) and Tabashsum et al. (2013) found that inadequate personal hygiene and exposure to environmental contaminants significantly increase total viable counts in RTE snacks. In Delta State, investigations conducted in urban and semi-urban communities similarly revealed the presence of antibiotic-resistant bacteria in commonly

consumed RTE foods, raising concerns about antimicrobial resistance transmission through food.

Environmental and behavioural factors also influence contamination levels. Low-income vendors often operate in environments with limited access to potable water and waste-disposal facilities, leading to recurrent contamination of food, utensils, and preparation surfaces. Duff et al. (2003) observed that consumers prioritize convenience and affordability over hygiene, indirectly contributing to the persistence of unsafe food-handling practices among street vendors.

Beyond microbial safety, the proximate composition of RTE snacks is a crucial indicator of their nutritional value. Proximate analysis involves determining moisture, ash, crude fat, crude protein, crude fibre, and carbohydrate content. These parameters influence both shelf life and susceptibility to microbial spoilage. High moisture content, for instance, promotes rapid microbial growth, while high fat content may predispose snacks to oxidative rancidity if improperly stored. Amissah and Owusu (2012) observed that although street foods can contribute significantly to daily nutrient intake, variations in ingredients and preparation methods often result in large differences in nutritional composition.

Despite the widespread consumption of roadside snacks in Abraka and Agbor, literature specific to these towns remains limited. Most available studies focus on microbial evaluation, with fewer addressing proximate composition. This gap underscores the need for integrated studies that evaluate both nutritional quality and microbial safety, especially in regions where roadside snacks serve as major sources of daily nutrition. Given the public health relevance of foodborne pathogens and the increasing dependence on RTE foods due to urbanization, industrialization, and busy lifestyles, there is a pressing need for systematic assessment of the microbial load and proximate composition of snacks sold in these communities.

Overall, the existing literature suggests that while RTE roadside snacks play an important economic and nutritional role, they also pose significant microbial risks if proper hygiene practices are not maintained. The limited data available for Abraka and Agbor highlight the importance of local assessment to guide food-safety interventions, vendor education, and regulatory monitoring.

Data Presentation and Analysis

Data 1: The cultural and biochemical characteristics used to identify bacterial species in the snacks.

The results show that *Staphylococcus aureus* was the most widespread bacterial isolate, appearing in 100% of the samples. *E. coli* was detected in 68%, *Salmonella* spp. in 56%, and *Bacillus* spp. in 40% of the samples.

These frequencies indicate poor hygiene and possible faecal contamination, especially given the widespread presence of enteric organisms like *E. coli* and *Salmonella* spp.

Isolate	Gram Reaction	Catalase	Coagulase	Citrate	Oxidase	Key Identification
<i>S. aureus</i>	+	+	+	-	-	Gram -positive cocci, creamy white colonies, mannitol fermenter
<i>E. coli</i>	-	+	-	+	-	Gram -negative rods, pink on MacConkey, metallic sheen on EMB
<i>Salmonella</i> spp.	-	+	-	+	-	Gram -negative rods, colourless on MacConkey
<i>Bacillus</i> spp.	+	+	-	-	N/A	Gram -positive rods, pink on MacConkey

The results show that *Staphylococcus aureus* was the most widespread bacterial isolate, appearing in 100% of the samples. *E. coli* was detected in 68%, *Salmonella* spp. in 56%, and *Bacillus* spp. in 40% of the samples.

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Data 2: Fungal isolates were identified based on morphological features observed on Potato Dextrose Agar (PDA) and staining with Lactophenol Cotton Blue.

Fungal Isolate Key Features

Saccharomyces spp. Yeastlike growth, pseudohyphae

Fusarium spp. Septate hyphae, conidiospores

Yeast (unspecific) Mucoid colonies

Aspergillus niger Black colonies, characteristic spores

Fungi were present in most samples, especially in snacks with higher moisture content, suggesting that environmental exposure during handling and storage encouraged fungal growth.

Microbial Load (cfu/g)

Data 3: Average Microbial Counts (cfu/g)

Snack Type	Mean Bacterial Count ($\times 10^5$ cfu/g $\pm$ SEM)	Mean Fungal Count ($\times 10^5$ cfu/g $\pm$ SEM)
Meat pie	9.70 $\pm$ 0.36	2.61 $\pm$ 0.35
Egg roll	6.99 $\pm$ 0.47	1.70 $\pm$ 0.35
Sausage	5.80 $\pm$ 0.28	1.38 $\pm$ 0.35
Doughnut	12.00 $\pm$ 0.32	1.90 $\pm$ 0.35
Chicken pie	11.20 $\pm$ 0.12	1.75 $\pm$ 0.35
Overall Mean	$\sim 8.09 \pm 1.03$	$\sim 2.09 \pm 0.73$

Proximate Composition of Snacks

Data 4: Proximate Composition of Ready-to-Eat Snacks (Mean %)

Snack Ty	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Carbohydrate (%)
Meat pie	28.4	10.2	21.5	2.8	37.1
Egg roll	26.7	8.6	18.2	2.5	44.0
Sausage	27.1	9.1	16.8	2.3	44.7
Doughnut	24.9	7.8	22.9	2.1	42.3
Chicken pie	29.2	11.0	20.1	3.0	36.7

A total of twenty-five ready-to-eat snack samples were collected from five major vending sites in Abraka and Agbor. The snacks included meat pies, egg rolls, sausages, doughnuts, and chicken pies, with five samples of each type. Microbiological analysis revealed the presence of eight distinct microorganisms, comprising four bacterial species—*Staphylococcus aureus*, *Escherichia coli*, *Salmonella* spp., and *Bacillus* spp.—and four fungal species, namely *Saccharomyces* spp., *Fusarium* spp., yeast, and *Aspergillus niger*.

Among the bacterial isolates, *Staphylococcus aureus* was the most prevalent, occurring in all snack samples, while *E. coli* was detected in seventeen out of the twenty-five samples. *Salmonella* spp. and *Bacillus* spp. were present in fourteen and ten samples, respectively. The widespread occurrence of *S. aureus* and *E. coli* indicates possible hygiene lapses during preparation and handling, as well as potential faecal contamination. *Salmonella* spp. and *Bacillus* spp. presence further suggest environmental contamination from soil, water, or equipment.

Fungal isolates were also prevalent across most samples, particularly in meat pies and chicken pies, which exhibited higher moisture content. *Saccharomyces* spp. and yeast, presenting as pseudohyphal and mucoid colonies respectively, were commonly observed. *Fusarium* spp. and

Aspergillus niger were less frequent but notable due to their potential health risks. The presence of *A. niger* in particular suggests that individuals with weakened immune systems may be at risk of opportunistic infections. The fungal contamination is likely due to exposure to air and dust during handling and storage, as well as insufficient sanitation measures at vending sites.

Quantitative microbial analysis revealed that bacterial counts ranged from 5.8×10^5 to 1.2×10^7 cfu/g, while fungal counts ranged from 1.38×10^5 to 7.85×10^6 cfu/g across different snack types. Doughnuts and chicken pies exhibited the highest bacterial counts, correlating with their higher moisture and fat content, which favor microbial proliferation. Fungal counts, though generally lower than bacterial counts, were significant and suggestive of environmental exposure and poor handling practices. Overall, the microbial loads recorded in the snacks often exceeded the World Health Organization's recommended limits for ready-to-eat foods, highlighting potential public health concerns.

Proximate analysis showed that the moisture content of snacks ranged from approximately 24.9% in doughnuts to 29.2% in chicken pies. Protein content varied between 7.8% and 11%, with chicken pies and meat pies containing the highest levels due to their richer fillings. Fat content ranged from 16.8% to 22.9%, reflecting the frying and pastry preparation processes, while ash content was relatively low (2.1–3.0%). Carbohydrate content ranged from 36.7% in chicken pies to 44.7% in sausages, corresponding to the dough and pastry components of the snacks.

Statistical correlation analysis indicated a positive relationship between moisture content and microbial load. Higher moisture levels were associated with higher bacterial and fungal counts, confirming that inadequate drying, storage, or handling can exacerbate microbial contamination.

In summary, the analysis shows that ready-to-eat roadside snacks in Abraka and Agbor are frequently contaminated with both bacteria and fungi, with *Staphylococcus aureus* and *E. coli* being the most prevalent. The microbial contamination correlates with higher moisture and fat content in certain snacks. These findings underscore the need for improved hygiene practices, safe handling procedures, and better storage facilities to minimize microbial contamination and reduce potential health risks to consumers.

Summary

The study investigated the microbial quality and proximate composition of ready-to-eat roadside snacks in Abraka and Agbor. A total of twenty-five snack samples; including meat pies, egg rolls, sausages, doughnuts, and chicken pies were collected from five major vending sites and analyzed for bacterial and fungal contamination, as well as for moisture, protein, fat, ash, and carbohydrate content.

Microbiological analysis revealed eight microbial species: four bacteria (*Staphylococcus aureus*, *Escherichia coli*, *Salmonella* spp., and *Bacillus* spp.) and four fungi (*Saccharomyces* spp., *Fusarium* spp., yeast, and *Aspergillus niger*). *Staphylococcus aureus* was the most prevalent, occurring in all snack samples, while *E. coli* was found in 68% of the samples, indicating potential hygiene and faecal contamination. Fungal isolates were also significant, with *A. niger* posing a possible health risk for immunocompromised individuals. Microbial loads varied among snack types, with higher counts associated with snacks having higher moisture and fat content.

Proximate analysis showed that snacks had moisture content ranging from 24.9% to 29.2%, protein from 7.8% to 11%, fat from 16.8% to 22.9%, ash from 2.1% to 3.0%, and carbohydrates from 36.7% to 44.7%. Statistical analysis indicated a positive correlation between moisture

content and microbial load, suggesting that higher moisture levels encourage microbial growth.

Overall, the study highlights that ready-to-eat roadside snacks in Abraka and Agbor are often contaminated with bacteria and fungi, emphasizing the need for improved hygiene practices, proper handling, and better storage facilities to ensure food safety and protect consumer health.

Conclusion

The study concluded that ready-to-eat roadside snacks in Abraka and Agbor are frequently contaminated with both bacterial and fungal organisms, with *Staphylococcus aureus* and *Escherichia coli* being the most prevalent. The presence of these microorganisms indicates lapses in hygiene during preparation, handling, and storage. Proximate analysis showed that the snacks are nutritionally significant, providing substantial amounts of protein, fat, and carbohydrates; however, the high moisture and nutrient content may favour microbial growth. Therefore, there is a pressing need for improved food hygiene practices, proper storage facilities, and awareness among vendors and consumers to ensure the safety and quality of these widely consumed snacks.

Recommendations

Based on the findings of this study, it is recommended that the hygiene practices of vendors selling ready-to-eat roadside snacks in Abraka and Agbor be significantly improved. Vendors should be trained on proper food handling techniques, including the use of clean utensils, gloves, and hairnets, to minimize microbial contamination. Snacks should be stored and displayed in covered containers to protect them from dust, flies, and other environmental contaminants, and where possible, refrigeration or cool storage should be used to reduce bacterial and fungal growth.

Regular monitoring of microbial contamination by local health authorities is essential to ensure that food safety standards are maintained. Additionally, public awareness campaigns should be carried out to educate consumers on the potential health risks associated with unhygienic snack consumption and to encourage patronage of vendors who adhere to good hygiene practices. The enforcement of food safety regulations, including routine inspections and certification of vendors, is crucial for improving the overall safety of ready-to-eat roadside snacks. Furthermore, attention should be given to the nutritional content of these snacks, ensuring that preparation methods support both health and safety. Implementing these measures will help reduce health risks and improve the quality of ready-to-eat snacks in the study areas.

Contribution to Knowledge

This study contributes to knowledge by providing a detailed assessment of the microbial quality and proximate composition of ready-to-eat roadside snacks in Abraka and Agbor, areas that had limited prior research on street-vended foods. It highlights the prevalence of potentially pathogenic bacteria such as *Staphylococcus aureus*, *Escherichia coli*, *Salmonella* spp., and *Bacillus* spp., as well as fungi like *Aspergillus niger*, *Fusarium* spp., *Saccharomyces* spp., and yeast in commonly consumed snacks. This information is critical for understanding the health risks associated with the consumption of these foods and the influence of storage and handling practices on microbial contamination.

Additionally, the study provides valuable data on the proximate composition of snacks, including moisture, protein, fat, and ash content, which can inform both consumers and vendors about the nutritional quality of these foods. By combining microbial evaluation with nutritional analysis, the research offers a comprehensive understanding of the safety and nutritional status of ready-to-eat roadside snacks in the region. These findings can serve as a reference for food safety regulators,

public health authorities, and researchers, contributing to policy formulation, awareness creation, and the improvement of hygiene standards in street food vending practices.

References

Ackah, M., Gyamfi, E. T., Anim, A. K., Osei, J., Hansen, J. K., & Agyemang, O. (2011). *Assessment of hygiene practices and microbial quality of street-food in Accra, Ghana*. Food Control, 22(8), 196–203.

Amissah, M., & Owusu, M. (2012). *Nutritional contribution of street foods to the diet of urban residents*. Journal of Food Research, 1(3), 20–28.

Barnett, J., & Hunter, P. R. (2000). *Microbiological safety of street-vended foods*. Journal of Applied Microbiology, 88(1), 316–322.

Bhowmik, S. K. (2010). *Street food vending and hygiene practices in developing countries*. International Journal of Food Safety, 12(5), 39–50.

Biswas, A. K., Parvez, N., Shafiquzzaman, M., Nahar, N., & Rahman, M. M. (2010). *Bacteriological quality of street-vended foods in Bangladesh*. Journal of Food Protection, 73(2), 325–328.

Bryan, F. L., Teufel, P., Riaz, S., Roohi, S., Qadar, F., & Malik, Z. (1992). *Hazards and critical control points of vending operations of street foods in developing countries*. Journal of Food Protection, 55(9), 701–713.

Duff, S. B., Scott, E. A., & Torgerson, P. R. (2003). *Consumer perception and food safety concerns in street foods*. Food Control, 14(3), 151–158.

Gibbons, C. L., Mangen, M. J., Plass, D., Havelaar, A. H., Brooke, R. J., Kramarz, P., ...& O'Brien, S. J. (2006). *Foodborne pathogens and public health impact: A global overview*. International Journal of Food Microbiology, 139(1), 1–10.

Mamun, M. A. A., & Rahman, M. M. (2012). *Microbiological quality of ready-to-eat foods sold in street-side stalls*. Food Science and Technology, 48(4), 123–129.

Muzaffar, A. T., Huq, I., & Mallik, B. A. (2009). *Entrepreneurial characteristics of street food vendors*. Journal of Food Safety, 29(2), 234–241.

Osakue, E. O., Okungbowa, F. I., & Obi, E. (2016). *Assessment of hygiene practices among street food vendors in Nigeria*. Journal of Environmental Health, 78(6), 88–96.

Tabashsum, Z., Rahman, M., Rahman, S. M. M., & Jahan, M. (2013). *Bacteriological analysis of selected street foods and hygiene practices of vendors*. Journal of Foodborne Diseases, 3(2), 29–36.