Nutritional Quality and Foodborne Pathogen Contamination of Ready-To-Eat Indigenous Foods in Bauchi State, Nigeria: Implications for Public Health

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Abstract
Ready-to-eat indigenous foods play an important role in dietary diversity, nutritional security, and the preservation of traditional food culture in northern Nigeria. However, their public health benefits may be compromised by microbiological contamination arising from inadequate food handling, poor sanitation, and inappropriate storage. This report reviews published evidence on the nutritional quality and microbiological safety of indigenous and ready-to-eat foods in Bauchi State, Nigeria. Evidence was drawn from studies investigating the nutrient composition of traditional composite foods in rural Bauchi communities and the microbiological quality of ready-to-eat foods sold in Azare and Gadau. Published nutritional analyses of 31 traditional composite foods demonstrated considerable variation in protein and mineral composition. Dambun naman rago contained 49.31% protein, while awara contained 16.86% protein, and dambun gero da zogale provided 6.01 mg iron and 89.64 mg calcium per 100 g. In a separate 2025 microbiological study involving 27 samples of awara, akara, and masa from Gadau, Staphylococcus aureus, Escherichia coli, Salmonella spp., and Pseudomonas spp. accounted for 51.9%, 25.9%, 18.5%, and 3.7%, respectively, of the reported bacterial isolates. A separate study of ready-to-eat salads in Azare also reported the presence of Salmonella spp., E. coli, and S. aureus. Collectively, these findings demonstrate the nutritional potential of indigenous foods alongside evidence of microbiological hazards in some ready-to-eat products. Improved vendor hygiene, safe storage, consumer education, routine surveillance, and standardized nutritional and microbiological assessment are recommended to support food safety and public health in Bauchi State.

Keywords: *Indigenous foods; nutritional composition; ready-to-eat foods; foodborne pathogens; food safety; public health; Bauchi State; Nigeria.*

Introduction

Indigenous foods are important components of traditional diets in Nigeria. In Bauchi State, commonly consumed foods include cereal-based preparations, legume-based products, traditional soups, meat products, and snacks sold in markets, food outlets, and roadside vending locations. These foods contribute to household food security and may provide protein, dietary fibre, energy, and essential minerals, depending on their ingredients and preparation methods.

Research conducted in rural Bauchi State has demonstrated that traditional composite foods can make meaningful contributions to dietary nutrient intake. Sosanya et al. investigated the proximate and mineral composition of 31 traditional foods, documenting variation in protein, iron, zinc, copper, and calcium concentrations across food categories.

Such evidence supports the importance of characterizing traditional foods when designing nutrition interventions and promoting locally available dietary resources.

Despite their nutritional importance, ready-to-eat foods can become contaminated during preparation, handling, transportation, display, and sale. Contamination may arise from inadequately cleaned utensils, unsafe water, contaminated raw ingredients, poor hand hygiene, cross-contamination, and prolonged storage at unsuitable temperatures.

Studies in Bauchi State have reported bacterial contamination in ready-to-eat foods. Abubakar and Joshua investigated salads sold in selected fast-food centres in Azare and reported Salmonella spp., Escherichia coli, and Staphylococcus aureus. More recently, Amoo et al. evaluated awara, akara, and masa sold around Sa'adu Zungur University, Gadau, and reported multiple bacterial contaminants in the sampled foods. These findings identify an important public health concern: foods with potential nutritional benefits may also present microbiological risks when hygiene and food safety practices are inadequate. Nevertheless, findings from separate studies cannot establish the nutritional quality and microbial safety of the same food samples.

The purpose of this report is therefore to synthesize published evidence on the nutritional composition of indigenous foods and the occurrence of foodborne bacterial hazards in ready-to-eat foods in Bauchi State, identify relevant public health implications, and recommend measures for improving food safety.

Statement of the Problem

Ready-to-eat indigenous foods are widely consumed in Bauchi State, Nigeria, because of their affordability, accessibility, cultural significance, and potential contribution to dietary nutrient intake. These foods may provide essential nutrients, including proteins, carbohydrates, fats, vitamins, and minerals, which are important for human growth, development, and general well-being. However, their nutritional quality and microbiological safety may be affected by food preparation methods, inadequate personal hygiene, contaminated water, poor sanitation, improper storage, and unhygienic food-handling practices. Previous studies conducted in Bauchi State have reported the nutritional composition of traditional foods and the presence of bacterial contaminants in selected ready-to-eat foods. Nevertheless, much of the available research has examined nutritional quality and microbiological safety separately, limiting understanding of the extent to which these two characteristics coexist in commonly consumed indigenous foods. The presence of potentially harmful microorganisms, including Escherichia coli, Salmonella spp., and Staphylococcus aureus, in ready-to-eat foods raises concerns about the potential risk of foodborne illnesses among consumers. Furthermore, limited integrated information is available on variations in nutrient composition and microbial contamination across different indigenous food types and vending locations in Bauchi State. This evidence gap makes it difficult to develop targeted food

safety interventions while promoting the nutritional benefits of locally available foods. Therefore, assessing the nutritional quality and foodborne pathogen contamination of selected ready-to-eat indigenous foods in Bauchi State is important for identifying potential nutritional benefits and microbiological hazards. The findings could provide evidence to support improved food-handling practices, strengthen food safety monitoring, protect consumers, and promote public health.

Research Objectives

To assess existing evidence on the nutritional quality and foodborne pathogen contamination of indigenous ready-to-eat foods in Bauchi State, Nigeria, and discuss their implications for public health.

Specific objectives

1. To summarize published findings on the proximate and mineral composition of indigenous foods consumed in Bauchi State.
2. To identify foodborne bacterial contaminants reported in selected ready-to-eat foods sold in the state.
3. To examine the potential implications of food contamination for consumer health and nutritional security.
4. To recommend practical interventions for improving food hygiene, nutritional assessment, and microbiological safety.

Scope of the Study

This study will focus on assessing the nutritional quality and foodborne pathogen contamination of selected ready-to-eat indigenous foods sold in Bauchi State, Nigeria, and examining the implications of the findings for public health. The study will cover selected food types commonly consumed by residents and obtained from designated markets, roadside vendors, and other food vending locations within the selected study areas. The nutritional assessment will focus primarily on the proximate composition of the selected foods, including moisture, crude protein, crude fat, ash, crude fibre, and carbohydrate contents. These parameters will be determined using appropriate standard laboratory procedures to establish the nutritional characteristics of the sampled foods. The microbiological aspect of the study will involve assessing the microbial quality of the selected foods and investigating the occurrence of specific foodborne pathogens, including Escherichia coli, Salmonella spp., Staphylococcus aureus, and Bacillus cereus, where appropriate and supported by the laboratory facilities available. Standard microbiological procedures will be used for the isolation, identification, and enumeration of relevant microorganisms.

The study will also compare the nutritional composition and microbiological quality of the selected foods across the sampled food types and vending locations. Where included in the research design, information on food-handling and vending practices will be collected to identify practices that may contribute to contamination. The public health assessment will focus on the potential risks associated with the detected microorganisms and the importance of hygienic food preparation, storage, handling, and vending practices. Geographically, the study will be restricted to selected locations within Bauchi State rather than covering every local government area. The specific locations, food categories, sample size, and number of vendors will be determined according to the sampling design, available resources, and feasibility of laboratory analysis.

The study will not directly measure the incidence of foodborne diseases among consumers or establish a causal relationship between consumption of the sampled foods and reported illnesses.

Its conclusions will therefore be based on the nutritional and microbiological results obtained from the sampled foods and any relevant food-handling data collected.

Literature Review

Introduction

This literature reviews relevant literature on the nutritional quality and foodborne pathogen contamination of ready-to-eat indigenous foods, with particular reference to Bauchi State, Nigeria. It examines the concepts of indigenous foods and ready-to-eat foods, their nutritional importance, factors influencing their nutritional composition, sources of microbial contamination, common foodborne pathogens, and the public health implications of consuming contaminated foods. The literature also considers food-handling practices, methods used in nutritional and microbiological assessments, relevant empirical studies, and gaps in existing research.

The review provides a theoretical and scientific foundation for investigating the nutritional composition and microbiological safety of selected indigenous foods sold in Bauchi State. It also establishes the relevance of evaluating nutritional quality and food safety together, since the dietary benefits of foods may be undermined when they are contaminated with pathogenic microorganisms.

Concept of Indigenous and Ready-to-Eat Foods

1 Indigenous Foods

Indigenous foods are food products traditionally consumed by particular communities and prepared using locally available ingredients, traditional knowledge, and established cultural practices. They may be derived from cereals, legumes, roots, tubers, vegetables, fruits, meat, fish, and animal products. Their production and preparation often reflect local agricultural resources, environmental conditions, religious practices, and cultural preferences.

In Nigeria, indigenous foods vary considerably across geographical regions and ethnic communities. In northeastern Nigeria, including Bauchi State, traditional diets may incorporate cereal-based products, bean-based foods, meat preparations, and dairy products, depending on local availability and household preferences. Examples of foods that may be relevant to a study of ready-to-eat indigenous foods include masa (a fermented cereal cake), akara (fried bean cake), and awara (soybean curd). The actual foods included in the present study should be determined through preliminary surveys of local markets and food vending locations.

Indigenous foods are important because they support dietary diversity, preserve cultural heritage, and provide economic opportunities for small-scale producers and vendors. Their use of locally available raw materials may also reduce dependence on certain imported food products. However, their nutritional value varies according to ingredients, proportions, processing methods, and serving sizes. Similarly, their safety depends on the quality of raw materials, processing conditions, sanitation, storage, and handling practices.

2 Ready-to-Eat Foods

Ready-to-eat (RTE) foods are foods intended to be consumed without an additional preparation step that would reliably eliminate microbiological hazards. They include freshly cooked meals, baked products, salads, snacks, and traditionally prepared foods sold for immediate consumption. Ready-to-eat foods may be produced in commercial facilities or prepared and sold by informal food vendors.

According to Makinde et al. (2020), ready-to-eat foods are widely consumed in low- and middle-income countries because of their convenience and contribution to daily dietary intake. However, these foods may be exposed to microbial contamination through inadequate handling, environmental exposure, and improper storage.

The microbiological safety of ready-to-eat foods is particularly important because consumers may eat them without further cooking. If contamination occurs after cooking, or if microorganisms survive inadequate cooking and subsequently multiply during storage, the consumer may be exposed to harmful microorganisms. Therefore, the assessment of ready-to-eat indigenous foods should consider both the nutritional benefits and the potential hazards associated with their preparation and sale.

Nutritional Quality of Ready-to-Eat Indigenous Foods

Nutritional quality refers to the ability of a food to supply nutrients in quantities and proportions that contribute to human nutritional requirements. It is influenced by nutrient composition, digestibility, bioavailability, preparation methods, portion size, and the overall dietary pattern in which the food is consumed. Ready-to-eat indigenous foods may provide substantial amounts of energy and essential nutrients. Cereal-based foods are commonly important sources of carbohydrates, while legumes contribute plant protein, dietary fibre, and minerals. Soybean-based foods may provide protein and fat, whereas meat and other animal-source foods can contribute protein, iron, zinc, and vitamin B12. Nevertheless, the nutritional value of any particular food must be established from its actual composition rather than inferred solely from its name or ingredients.

1 Moisture Content

Moisture content represents the amount of water present in a food. It influences food texture, weight, shelf life, and susceptibility to microbial deterioration. Foods with high moisture content may support the growth of many microorganisms when other conditions, particularly temperature and water availability, are favourable. Moisture analysis is therefore important when evaluating the nutritional composition and storage stability of ready-to-eat indigenous foods. However, moisture content alone cannot establish whether a food is microbiologically safe. Water activity, acidity, temperature, preservatives, and the types of microorganisms present also influence microbial growth.

2 Crude Protein

Protein is essential for growth, tissue repair, enzyme production, hormone synthesis, and immune function. Legumes, soybean products, meat, milk, and other protein-containing ingredients may contribute to the protein content of indigenous foods. The crude protein content of a food is commonly estimated from its nitrogen content using an appropriate analytical method and conversion factor. The resulting value provides an estimate of total protein but does not necessarily indicate protein quality, digestibility, or the adequacy of essential amino acids. Determining the crude protein content of selected ready-to-eat indigenous foods in Bauchi State will help describe their potential contribution to dietary protein intake and allow comparisons between different food types.

3 Crude Fat

Fat provides concentrated dietary energy, supplies essential fatty acids, and facilitates the absorption of fat-soluble vitamins. It also contributes to the flavour, texture, and palatability of foods. The fat content of indigenous ready-to-eat foods depends on the ingredients used and the methods of preparation. For example, frying can increase the fat content of a food through oil absorption, although the amount absorbed varies with the food's structure, temperature, cooking duration, and oil properties. Fat analysis can therefore help explain differences in the energy density of sampled foods.

4 Ash Content

Ash represents the inorganic residue remaining after the organic components of a food have been destroyed through incineration under controlled conditions. It is commonly used as an estimate of total mineral residue. Although ash content can provide a general indication of mineral matter, it does not identify the individual minerals present or establish their nutritional bioavailability. Specific mineral analyses are required when the objective is to quantify nutrients such as iron, calcium, zinc, or magnesium.

5 Crude Fibre

Crude fibre is an operational measure of certain fibrous components of food obtained through a prescribed analytical procedure. It is associated with the structural components of plant foods and can help distinguish the composition of cereal-based, legume-based, and other plant-derived foods.Crude fibre should not be treated as equivalent to total dietary fibre because the analytical method does not recover all dietary fibre components. Nevertheless, it may provide useful comparative information when the same validated method is applied to all sampled foods.

6 Carbohydrate Content

Carbohydrates are important sources of dietary energy. Cereals and other starchy ingredients commonly contribute substantially to the carbohydrate content of indigenous foods.

In proximate analysis, carbohydrate may be estimated by difference after subtracting measured moisture, protein, fat, ash, and, where applicable, fibre from the total sample mass. When carbohydrate is calculated in this manner, analytical errors in the other components may affect the resulting estimate. The method used should therefore be stated clearly when presenting results.

Factors Affecting Nutritional Composition

The nutritional composition of ready-to-eat indigenous foods can be influenced by several factors:

1. **Raw material quality:** Different cereal varieties, legume species, and animal-source ingredients have different nutrient profiles.
2. **Processing methods:** Fermentation, soaking, milling, dehulling, and cooking can alter nutrient availability and composition.
3. **Cooking conditions:** Prolonged heating may reduce certain heat-sensitive nutrients, while cooking can improve the digestibility of some food components.
4. **Frying and oil absorption:** The type of oil and frying conditions may influence fat content and energy density.
5. **Storage:** Prolonged or unsuitable storage can affect product quality and may lead to nutrient degradation.
6. **Recipe formulation:** Differences in ingredient proportions can produce substantial variation

between foods bearing the same traditional name.
Consequently, laboratory analysis is necessary to establish the composition of the particular foods sampled in Bauchi State rather than relying exclusively on general food-composition tables.

Microbiological Quality of Ready-to-Eat Foods

Microbiological quality refers to the types and quantities of microorganisms present in a food and their significance for food safety, spoilage, and suitability for consumption. Some microorganisms are harmless or beneficial, especially in fermented foods, while others may cause deterioration or disease. Microbiological assessment may include total aerobic viable counts, coliform counts, and the detection or enumeration of specific pathogens. These measurements provide different types of information and should not be interpreted as interchangeable.
Total viable counts provide an indication of the cultivable microbial population under the specified laboratory conditions. Coliforms and E. coli may provide evidence of hygiene failures or contamination, depending on the organism and context. Pathogen-specific testing is necessary to determine whether particular disease-causing microorganisms are present.
A high general bacterial count does not automatically demonstrate the presence of a foodborne pathogen, while a low general count does not guarantee that a food is free from dangerous microorganisms. Interpretation should therefore consider the relevant microbiological criteria, the food type, the method used, and the identity and quantity of organisms detected.
Research in Nigeria has documented microbial contamination concerns in ready-to-eat foods. A systematic review by Makinde et al. (2020) examined microbiological safety evidence from low- and middle-income countries, including challenges associated with informal food vending. Similarly, a systematic review of fresh vegetables and ready-to-eat salads in Nigeria identified microbiological safety as an important concern in foods that may be consumed without further cooking (Profit et al., 2021).

Common Foodborne Pathogens Associated with Ready-to-Eat Foods

Foodborne pathogens are microorganisms capable of causing disease when they enter the human body through contaminated food. Their presence in ready-to-eat foods may result from contaminated ingredients, poor hygiene, inadequate cooking, cross-contamination, or improper storage. The organisms selected for investigation should reflect the food types, expected hazards, laboratory capacity, and applicable microbiological standards.

1 Escherichia coli

Escherichia coli is a bacterial species commonly found in the intestinal tract of humans and other warm-blooded animals. Although many strains are harmless, certain pathogenic strains can cause diarrhoea and other serious illnesses. The detection of E. coli in ready-to-eat foods may indicate faecal contamination or deficiencies in hygiene, depending on the circumstances and the testing method. Possible routes of contamination include the use of unsafe water, inadequate handwashing, contaminated utensils, and contact with raw materials carrying faecal microorganisms. Foods handled extensively after cooking may be particularly vulnerable when hygiene is poor. The identification of E. coli in this study would therefore be relevant to assessing the hygienic quality of the selected foods. However, routine identification of the species does not establish that a pathogenic strain is present; additional testing may be required to identify disease-associated strains.

2 Salmonella Species

Salmonella species are important foodborne pathogens that can cause salmonellosis. Common symptoms include diarrhoea, fever, abdominal cramps, and vomiting. Severe infections may occur in vulnerable individuals. Contamination can arise through infected animals, contaminated raw meat, poultry, eggs, milk, water, or contaminated food-contact surfaces. Inadequate cooking and cross-contamination between raw and cooked foods can contribute to transmission.

Because ready-to-eat foods may be consumed without further heating, the detection of Salmonella is an important food safety concern. Laboratory investigation should use appropriate validated detection and confirmation methods, with results interpreted according to relevant standards.

3 Staphylococcus aureus

Staphylococcus aureus is commonly associated with human skin, nasal passages, and hands. Food may become contaminated when handlers touch cooked foods without adequate hygiene or when infected skin lesions are not properly covered.

Under favourable conditions, certain strains can multiply in food and produce enterotoxins that cause staphylococcal food poisoning. Symptoms can include sudden nausea, vomiting, abdominal cramps, and diarrhoea. An important concern is that some staphylococcal enterotoxins are heat-stable. Consequently, reheating food may not reliably eliminate the risk once sufficient toxin has accumulated. Prevention through hygienic handling and appropriate temperature control is therefore essential.

4 Bacillus cereus

Bacillus cereus is a spore-forming bacterium found widely in the environment, including soil and dust. Its spores may contaminate cereals, rice, flour, spices, and other raw ingredients. Some spores can survive cooking and subsequently germinate when food is stored under favourable conditions. Certain strains cause diarrhoeal illness, while others produce a toxin associated with vomiting. Improper cooling and prolonged storage at unsuitable temperatures can contribute to risk, particularly in cooked starchy foods. The investigation of B. cereus may therefore be relevant where the selected indigenous foods include cereal-based products or other foods in which this organism is a plausible hazard. Detection and enumeration should follow suitable laboratory protocols.Research reviews have identified E. coli, Salmonella, and S. aureus among important bacterial hazards reported in foods across African countries and in ready-to-eat foods in low- and middle-income settings (Makinde et al., 2020; the African foodborne-pathogen meta-analysis, 2017).

Sources and Factors Contributing to Food Contamination

Microbial contamination may occur at any point between the production of raw materials and the consumption of finished food. The principal factors relevant to ready-to-eat indigenous foods include the following.

1 Personal Hygiene of Food Handlers

Food handlers can transfer microorganisms to food through contaminated hands, clothing, utensils, or uncovered wounds. Inadequate handwashing after using the toilet, handling raw ingredients, or touching contaminated surfaces may increase the risk of contamination.

Appropriate handwashing facilities, clean protective clothing, safe handling procedures, and the exclusion or proper management of ill food handlers are important preventive measures.

2 Water Quality

Water is used for washing ingredients, preparing foods, cleaning utensils, and maintaining personal hygiene. If the water supply is contaminated, it can introduce microorganisms into food or onto food-contact surfaces. The use of potable water is therefore a central component of food safety. Water quality is particularly relevant for ready-to-eat foods that undergo extensive washing or receive ingredients after cooking.

3 Food Preparation and Cooking

Adequate cooking can destroy many vegetative foodborne pathogens. However, insufficient heating, uneven cooking, and contamination after cooking may compromise food safety.

Cross-contamination can occur when cooked foods come into contact with raw meat, unwashed vegetables, contaminated utensils, or unclean work surfaces. Separating raw and cooked foods and maintaining clean preparation areas can help reduce this risk.

4 Storage Temperature and Duration

Temperature and storage duration influence microbial survival and multiplication. Foods kept for extended periods at temperatures favourable to microbial growth may become unsafe, particularly when they contain sufficient moisture and nutrients.

Appropriate hot holding, rapid cooling, refrigeration where available, and protection from repeated handling are important control measures. Storage conditions should be evaluated in relation to the type of food and its preparation method.

5 Environmental Sanitation and Food Display

Dust, insects, waste, pests, and contaminated surfaces can expose foods to microorganisms. Open-air vending environments may increase exposure when foods are left uncovered or displayed near waste disposal sites and drainage systems. Covered display containers, clean vending surfaces, appropriate waste management, and access to sanitation facilities can reduce these risks.

A review of Nigerian food safety research by Food Control (2022) found that many studies concentrated on individual cities or states and that reported food safety knowledge was not always reflected in observed practices. This suggests that food safety interventions should address actual handling behaviour and the conditions in which vendors work, rather than relying on awareness campaigns alone.

Public Health Implications of Contaminated Ready-to-Eat Foods

Foodborne illnesses remain an important public health concern because contaminated foods can transmit infectious microorganisms and toxins. The World Health Organization reports that unsafe food can cause more than 200 diseases and contributes to illness, mortality, and economic losses worldwide. The burden is particularly concerning for children under five and other vulnerable groups.

The potential public health implications of contaminated ready-to-eat foods include:

1. Gastrointestinal illness: Pathogens can cause diarrhoea, vomiting, abdominal pain, and fever.
2. Severe complications: Some infections can lead to dehydration, bloodstream infection, or other serious complications.
3. Increased healthcare costs: Foodborne illness may result in clinic visits, hospitalisation, and expenditure on treatment.

4. Loss of productivity: Illness can interfere with work, education, and household responsibilities.
5. Nutritional consequences: Repeated gastrointestinal illness can impair nutrient absorption and worsen nutritional vulnerability, particularly among young children.
6. Community-level outbreaks: Foods distributed widely or sold to many consumers may expose several individuals to the same hazard.

It is important to distinguish the detection of pathogens in food from the demonstration of disease in consumers. A food analysis can identify potential hazards, but determining the incidence of illness or proving that a particular food caused an outbreak requires additional epidemiological evidence.

Empirical Review of Related Studies

1 Sosanya et al. (2020): Nutritional composition of traditional foods in Bauchi State

Sosanya et al. (2020) evaluated the proximate and mineral composition of 31 traditional composite foods consumed in rural Bauchi State. Proximate analysis was conducted using a modified Association of Official Analytical Chemists (AOAC) method, while iron, zinc, copper, and calcium were measured using atomic absorption spectrophotometry.

The researchers reported considerable variation in nutrient composition among the food categories. Dambun naman rago and awara had reported protein contents of 49.31% and 16.86%, respectively. The study also identified traditional cereal-and-legume combinations that provided useful amounts of selected minerals. The study provides important baseline evidence for the nutritional value of traditional foods in Bauchi State. However, its principal focus was nutritional composition rather than the microbiological safety of the same food samples. It therefore does not establish whether the foods with higher nutrient concentrations were free from foodborne pathogens.

2 Sosanya et al. (2021): Characterization of traditional foods and diets

Sosanya et al. (2021) further examined the nutrient composition of 31 traditional composite foods consumed in rural Bauchi State. Their investigation highlighted the contribution of locally available ingredients, particularly legumes, peanut cake, soy products, and cereals, to the protein and mineral content of traditional diets.

The authors concluded that certain indigenous foods have useful nutritional profiles and may contribute to improving dietary quality among rural households.

This study supports the need to preserve and promote nutritious traditional foods. Nevertheless, the study did not provide a comprehensive assessment of foodborne pathogen contamination in those same samples, leaving an important question concerning the relationship between nutritional value and microbiological safety.

3 Abubakar and Joshua (2022): Bacteriological assessment of ready-to-eat salads in Azare

Abubakar and Joshua (2022) investigated the bacteriological quality of ready-to-eat salads obtained from selected fast-food centres in Azare, Bauchi State. Their study identified bacterial organisms including Salmonella spp., E. coli, and S. aureus. Reported bacterial colony counts ranged from 3.01×1013.01 \times 10^1 to 1.5×1031.5 \times 10^3 CFU/g.

The study demonstrated that foods consumed without further cooking may be exposed to microbiological hazards during preparation and handling. Its findings emphasize the importance of safe water, appropriate vegetable washing, hygienic utensils, and prevention of cross-contamination.

However, the investigation focused on salads from selected establishments in Azare. It cannot establish the contamination status of all indigenous ready-to-eat foods throughout Bauchi State, and it did not simultaneously determine the proximate and mineral composition of the sampled salads.

4 Amoo et al. (2025): Microbiological evaluation of ready-to-eat foods in Gadau

Amoo et al. (2025) assessed the microbiological quality of awara, akara, and masa sold around Sa'adu Zungur University, Gadau, Bauchi State. The researchers collected 27 samples from cafeteria, market, and off-campus locations over one month. Standard microbiological procedures, including serial dilution, inoculation, incubation, microscopy, and biochemical tests, were used to identify bacterial contaminants. The authors reported S. aureus, E. coli, Salmonella spp., and Pseudomonas spp. among the isolates. Awara had the highest reported total aerobic bacterial count, while akara had the highest total coliform and staphylococcal counts among the food categories examined. The authors identified food hygiene as an important concern and recommended improved vendor training and monitoring. This study provides recent evidence of microbiological hazards in selected ready-to-eat foods in Bauchi State. However, its relatively small, geographically limited sample cannot represent all vendors or food categories across the state. Furthermore, the study did not establish the nutritional composition of the same samples, so the relationship between nutrient content and microbial contamination remains undetermined.

Public Health Implications of Contaminated Indigenous Foods

1 Foodborne illness

Consumption of food contaminated with pathogenic microorganisms may lead to diarrhoea, vomiting, abdominal pain, fever, and other clinical manifestations. The severity of illness depends on the organism, the quantity consumed, the characteristics of the food, and the susceptibility of the individual. The detection of potentially pathogenic bacteria in ready-to-eat foods in Bauchi State therefore warrants attention from public health authorities, food vendors, and consumers.

2 Nutritional insecurity

Foodborne illness can interfere with food intake and nutrient absorption, particularly when episodes are frequent or severe. In vulnerable individuals, repeated illness may contribute to poor nutritional outcomes. Consequently, improving access to food should involve both nutritional promotion and food safety measures. Foods that are affordable and nutritionally valuable should also be prepared and handled in ways that minimize microbiological hazards.

3 Vulnerable population groups

Young children, older adults, pregnant women, and immunocompromised individuals may face greater risks from certain foodborne infections. Protecting these groups requires particular attention to safe preparation, proper storage, and avoidance of foods that have been handled or stored under unsafe conditions.

4 Economic and community implications

Foodborne illnesses can result in medical expenses, lost working hours, reduced productivity, and loss of consumer confidence in food vendors. Improving food safety may therefore benefit not only individual health but also local livelihoods and the sustainability of indigenous food businesses.

Strategies for Improving the Safety of Indigenous Foods

Improving the safety of ready-to-eat indigenous foods requires coordinated action by food vendors, consumers, public health authorities, and regulatory agencies.

Key strategies include:

1. **Good hygiene practices:** Promote handwashing, clean clothing, hygienic food handling, and proper cleaning of utensils and surfaces.
2. **Safe water supply:** Ensure that water used for food preparation, washing, and cleaning is suitable for its intended use.
3. **Appropriate storage:** Apply suitable time and temperature controls to minimize microbial growth.
4. **Food safety training:** Provide regular, practical training for street food vendors, market traders, and food handlers.
5. **Microbiological surveillance:** Conduct routine testing of selected high-risk ready-to-eat foods using validated laboratory methods.
6. **Regulatory monitoring:** Strengthen food hygiene inspections and implement applicable national food safety requirements.
7. **Consumer awareness:** Educate consumers on selecting hygienically prepared foods and recognizing unsafe storage and handling conditions.

These measures are consistent with the principles promoted by NAFDAC's Guidelines for Food Hygienic Practices and established international food hygiene guidance.

Research Gap

Although previous studies have investigated the nutritional composition of indigenous foods and the microbiological quality of ready-to-eat foods in Bauchi State, limited evidence is available that evaluates both aspects simultaneously in the same food samples. Existing nutritional studies have focused on proximate composition and mineral content, while microbiological investigations have examined bacterial contamination in selected ready-to-eat foods sold in locations such as Azare and Gadau. Consequently, there is insufficient integrated evidence to establish the relationship between the nutritional quality and microbiological safety of indigenous ready-to-eat foods in Bauchi State. Furthermore, the available studies do not adequately establish the variation in nutritional composition and pathogen contamination across different food types, vending locations, and food-handling practices. Information on the potential public health implications of consuming contaminated but nutritionally valuable indigenous foods also remains limited.

Therefore, this study seeks to address this gap by assessing the nutritional composition and foodborne pathogen contamination of selected indigenous ready-to-eat foods in Bauchi State, Nigeria. By evaluating nutritional and microbiological parameters together, the research could provide evidence to guide food safety monitoring, vendor education, consumer protection, and public health interventions.

Research Methodology

The study adopted a narrative review approach to examine the nutritional quality and foodborne pathogen contamination of indigenous ready-to-eat foods in Bauchi State, Nigeria. Relevant published studies on traditional food composition and the microbiological quality of ready-to-eat foods in locations including Azare and Gadau were reviewed. Data were extracted on food types, nutritional composition, bacterial isolates, microbial counts, and public health implications. Nutritional findings were summarized according to proximate composition and mineral content,

while microbiological findings were categorized by the organisms identified and their reported levels of contamination. The evidence was synthesized descriptively, without pooling results from studies with different sampling designs and laboratory methods. The findings were used to identify food safety concerns and recommend measures to improve food hygiene, nutritional assessment, and public health protection.

Discussion of Results

1 Nutritional Composition of Selected Ready-to-Eat Indigenous Foods

The nutritional composition of the selected ready-to-eat indigenous foods will be discussed based on the results of proximate analysis, including moisture, crude protein, crude fat, ash, crude fibre, and carbohydrate contents. Differences in nutritional composition among foods such as masa, akara, and awara may be associated with differences in their raw materials, ingredient proportions, fermentation, frying, and other preparation methods. For example, legume-based foods may contribute appreciable protein, while cereal-based foods may provide substantial carbohydrates. However, the relative nutritional value of each food must be established from the laboratory results. Moisture content will be considered in relation to food composition and storage stability. Crude protein and fat values will help describe the potential contribution of the foods to dietary energy and nutrient intake. Ash content will provide an estimate of total mineral residue, while crude fibre and carbohydrate measurements will contribute to the overall nutritional profile.

The findings should be compared with relevant published studies and interpreted in relation to differences in ingredients, processing techniques, analytical methods, and sample characteristics.

2 Microbiological Quality of the Foods

The microbiological quality of the selected foods will be discussed using the measured microbial counts and the occurrence of selected pathogens, including Escherichia coli, Salmonella spp., Staphylococcus aureus, and Bacillus cereus. High microbial counts may indicate poor hygiene, inadequate processing, contamination after cooking, or unsuitable storage conditions. However, general microbial counts alone cannot establish the presence of specific pathogens. The identification and confirmation of individual organisms are therefore important for assessing potential food safety concerns. The results should be compared with applicable microbiological criteria for the relevant food categories. The presence of a confirmed pathogen may indicate a food safety concern, while its non-detection means only that it was not detected under the conditions and limits of the test.

3 Comparison of Results Across Food Types and Locations

Differences in nutritional composition and microbial contamination among food types and sampling locations will be examined to determine whether the observed variations are statistically significant. Variations may be associated with ingredient composition, preparation methods, water quality, personal hygiene, utensil cleanliness, food covering, and storage conditions. If food-handling practices are included in the study, their relationship with microbial contamination can be assessed statistically. Any explanation of these differences should be based on the evidence collected rather than assumptions about individual vendors or locations.

4 Public Health Implications

The public health implications will be interpreted by considering both nutritional composition and microbiological safety. Foods with valuable nutrient profiles may still pose health risks if they

contain foodborne pathogens. Conversely, satisfactory microbiological results do not necessarily indicate high nutritional quality.

The discussion should identify any confirmed food safety concerns and recommend appropriate interventions, including improved personal hygiene, the use of safe water, proper cooking, hygienic food display, and suitable storage conditions.

The results should not be used to estimate the actual incidence of foodborne illness in Bauchi State unless consumer health or epidemiological data have also been collected.

Summary Of Findings

This report reviewed published evidence on the nutritional quality and microbiological safety of selected indigenous and ready-to-eat foods in Bauchi State, Nigeria. The major findings are summarized as follows:

1. Nutritional quality: Research by Sosanya et al. (2020) on traditional composite foods consumed in rural Bauchi State demonstrated considerable variation in nutrient composition. Selected foods, including dambun naman rago, awara, and dambun gero da zogale, contained useful amounts of protein and selected minerals.

2. Bacterial contamination: Amoo et al. (2025) reported bacterial isolates from ready-to-eat foods sold around Sa'adu Zungur University, Gadau. The identified organisms included Staphylococcus aureus, Escherichia coli, Salmonella spp., and Pseudomonas spp.

3. Contamination of salads: Abubakar and Joshua (2022) reported the presence of Salmonella spp., E. coli, and S. aureus in ready-to-eat salads obtained from selected fast-food centres in Azare.

4. Public health implications: The reported presence of potentially pathogenic bacteria in some ready-to-eat foods raises concerns about food hygiene, handling, storage, and sanitation. However, the detection of an organism does not necessarily establish that it caused illness or that a toxin was present.

5. Research gap: The reviewed studies examined nutritional composition and microbiological safety largely as separate issues. Consequently, there is insufficient integrated evidence to determine the relationship between the nutritional quality and microbiological safety of the same food samples across Bauchi State.

These findings are based on previously published studies and should not be interpreted as results from a new laboratory investigation.

Conclusion

Indigenous foods are important components of diets in Bauchi State because they contribute to dietary diversity and can provide essential nutrients, including proteins and minerals. Nevertheless, published microbiological investigations have identified potentially harmful bacterial organisms in selected ready-to-eat foods, highlighting the importance of food safety in protecting public health. The evidence indicates that nutritional quality and microbiological safety should be considered together when evaluating the contribution of indigenous foods to public health. Although the reviewed studies demonstrate the nutritional potential of traditional foods and the presence of microbiological hazards in certain ready-to-eat products, they do not establish the overall prevalence of contamination throughout Bauchi State or a direct relationship between nutrient composition and pathogen contamination.

An integrated investigation involving nutritional and microbiological analyses of the same food samples is therefore necessary. Such research would provide more comprehensive evidence to

guide food safety policies, improve food-handling practices, and promote the consumption of nutritious and microbiologically safe indigenous foods.

Recommendations

Based on the reviewed evidence, the following recommendations are proposed:

1. Improved food hygiene: Food vendors should maintain proper personal hygiene, wash their hands regularly, clean utensils and preparation surfaces, and prevent contact between raw and cooked foods.

2. Provision of safe water: Local authorities and relevant stakeholders should improve access to potable water and appropriate sanitation facilities in markets, food vending locations, and public eating establishments.

3. Food safety training: Regular training should be provided for food handlers on safe food preparation, temperature control, hygienic storage, and prevention of cross-contamination.

4. Routine microbiological surveillance: Relevant public health and regulatory agencies should periodically assess the microbiological quality of commonly consumed ready-to-eat foods in Bauchi State.

5. Nutritional assessment: Further laboratory studies should determine the proximate composition and selected micronutrient content of locally consumed indigenous foods to support nutrition education and dietary planning.

6. Integrated research: Future studies should assess nutritional composition and microbiological contamination in the same food samples, collected from multiple food types and vending locations across Bauchi State.

7. Consumer education: Consumers should be encouraged to purchase foods from vendors who demonstrate good hygiene, protect foods from dust and insects, and maintain appropriate storage conditions.

8. Strengthened regulatory enforcement: Food safety authorities should implement applicable food hygiene requirements and support vendors in adopting safer practices.

9. Further epidemiological research: Additional studies should investigate the relationship between consumption of contaminated ready-to-eat foods and foodborne illness, using appropriate epidemiological methods.

10. Support for indigenous food systems: Public health programmes should promote traditional foods with useful nutritional profiles while emphasizing hygienic preparation, safe storage, and microbiological quality.

References

- Amoo, F. K., et al. (2025). Microbiological evaluation of ready-to-eat foods sold around Sa'adu Zungur University Gadau, Bauchi, Nigeria: Implications for food safety and public health. FUDMA Journal of Sciences, 9(3), 194–200. https://doi.org/10.33003/fjs-2025-0903-3272
- Abubakar, A., & Joshua, T. (2022). Bacteriological assessment on ready-to-eat salad sold in some fast food centers in Azare town, Bauchi State, Nigeria. Gadau Journal of Pure and Allied Sciences, 1(1), 68–72. https://doi.org/10.54117/gjpas.v1i1.23
National Agency for Food and Drug Administration and Control. (2024). NAFDAC Guidelines for Food Hygienic Practices. https://nafdac.gov.ng/find-out-all-you-need-to-know-about-the-regulations-on-nafdac-regulated-food-products/
- Sosanya, M. E., et al. (2020). Proximate and mineral composition of traditional, composite foods consumed in rural areas of Bauchi State, Nigeria. Current Developments in Nutrition, 4(Supplement 2), 780. https://doi.org/10.1093/cdn/nzaa052_049
Sosanya, M. E., Freeland-Graves, J. H., Gbemileke, A. O., Adeosun, F. F., Samuel, F. O., & Shokunbi, O. (2021). Characterization of traditional foods and diets in rural areas of Bauchi State, Nigeria: Analysis of nutrient components. European Journal of Nutrition & Food Safety, 13(7), 1–16. https://doi.org/10.9734/EJNFS/2021/v13i730432
World Health Organization. (2026). Food safety. https://www.who.int/news-room/fact-sheets/detail/food-safety

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