**EVALUATION OF BACTERIA CONTAMINATION OF AFRICAN SALAD (ABACHA) SOLD IN ENUGU METROPOLIS**

**ABSTRACT**

Abacha is a widely consumed delicacy in Nigeria, but improper handling and unhygienic preparation practices can lead to microbial contamination, posing health risks. The study aimed to isolate and identify bacterial species, assess contamination levels, and evaluate antibiotic sensitivity of the isolates. A cross-sectional study design was employed over six months, from July to December. The study area covered three major locations in Enugu Metropolis: Abakpa, Old Park, and New Market. A total of 30 *Abacha* samples were collected from vendors in three locations: Abakpa, Old Park, and New Market. Standard microbiological techniques were used to isolate and identify bacterial species. Antibiotic sensitivity testing was conducted using the disk diffusion method. The results showed that 53.3% of the samples were contaminated with bacteria, while 46.7% exhibited no growth. *Staphylococcus aureus* (50.0%) was the most prevalent isolate, followed by *Pseudomonas aeruginosa* (31.2%) and *Escherichia coli* (18.8%). Bacterial contamination varied across locations, with Abakpa having the highest prevalence (60.0%). Antibiotic susceptibility testing revealed high sensitivity to gentamicin and ciprofloxacin, while resistance was notable against ceftriaxone and tetracycline. The findings align with previous studies, underscoring the significant public health risks associated with street-vended foods due to poor hygiene practices. Compared to other studies, the high resistance rates observed in some antibiotics emphasize the growing challenge of antimicrobial resistance. In conclusion, the study highlights the need for improved hygiene practices among vendors, stricter regulatory oversight, and access to clean water during food preparation. Public health awareness campaigns should focus on educating both vendors and consumers about the risks of bacterial contamination. Further research is recommended to evaluate the effectiveness of interventions aimed at improving the microbiological safety of street-vended foods.

1. **Introduction**

African salad (Abacha) is a popular traditional dish in southeastern Nigeria, prepared from cassava tubers that are boiled, shredded, fermented, and sun-dried. While cherished for its flavor and cultural importance, Abacha is often prepared and sold in environments lacking sanitary controls, exposing it to bacterial contamination (Igbinosa et al., 2018). Such contamination poses significant public health risks, including foodborne illnesses caused by pathogens like Staphylococcus aureus*, Escherichia coli*, and *Salmonella spp.* (Eze et al., 2017).

This study aimed to evaluate the microbial contamination of Abacha sold in Enugu Metropolis, identify common bacterial isolates, assess their antibiotic resistance profiles, and suggest strategies for mitigating contamination.

**Aims and Objectives**

1. **To Isolate and Identify Bacterial Species Present in Abacha Samples Collected from Vendors in Enugu Metropolis**
2. To Check the Sensitivity of Various Bacterial Isolates in Abacha Sold in Enugu Metropolis
3. To determine the level of Bacteria contamination of African salad(Abacha) sold on Enugu Metropolis
4. **Materials and Method**

**Study Design and Sample Collection**

A cross-sectional study was conducted, collecting 30 Abacha samples from three major areas in Enugu Metropolis: Abakpa (n=10), Old Park (n=10), and New Market (n=10). Samples were aseptically collected in sterile containers and transported to the laboratory for analysis.

**Microbiological Analysis**

Standard microbiological techniques were used to isolate and identify bacterial species. Samples were cultured on selective media, and isolates were identified based on morphological, biochemical, and serological characteristics.

**Antibiotic Sensitivity Testing**

Antibiotic susceptibility of bacterial isolates was determined using the Kirby-Bauer disk diffusion method. Results were interpreted according to Clinical and Laboratory Standards Institute (CLSI) guidelines.

1. **Results**

 Out of 30 Abacha samples analyzed, 53.3% showed bacterial growth, while 46.7% exhibited no contamination (Table 1). The most frequently isolated bacteria were *Staphylococcus aureus* (50.0%), followed by *Pseudomonas aeruginosa* (31.2%) and *Escherichia coli* (18.8%)

 **Table 1: Isolated and identified bacterial species present in African salad (abacha) samples collected from vendors in Enugu metropolis**

|  |  |
| --- | --- |
| **African salad (abacha) samples collected from** **vendors in Enugu metropolis (n=30)** | **Prevalence** |
| **N** | **%** |
| No bacterial growth | 14 | 46.7 |
| Bacteria Growth  | 16 | 53.3 |
| *Staphylococcus aureus**Escherichia coli**Pseudomonas aeruginosa* | 835 | 50.018.831.2 |

Table 1 highlights the bacterial contamination in African salad (abacha) samples collected from vendors in Enugu metropolis. Out of 30 samples analyzed, 46.7% exhibited no bacterial growth, indicating relatively hygienic handling practices in these cases. However, 53.3% of the samples were contaminated with bacteria, demonstrating a significant prevalence of microbial contamination. Among the identified bacterial species, Staphylococcus aureus was the most frequently isolated, accounting for 50.0% of the contaminated samples. Pseudomonas aeruginosa followed at 31.2%, while Escherichia coli constituted 18.8%.

**Figure 1**: Graphical representation of Isolated and identified bacterial species present in African salad (abacha) samples collected from vendors in Enugu metropolis

 **Table 2: Levels of bacterial contamination of African salad (abacha) sold in different areas of Enugu Metropolis**

|  |  |
| --- | --- |
| **Different areas of Enugu Metropolis****(n=30)** | **Prevalence** |
| **Bacterial contamination****N (%)** | **Non-bacterial contamination****N (%)** |
| Abakpa (n=10) | 6 (60.0) | 4 (40.0) |
| Old Park (n=10) | 5 (50.0) | 5 (50.0) |
| New market (n=10) | 5 (50.0) | 5 (50.0) |

Table 2 examines bacterial contamination levels in African salad (abacha) sold across three areas in Enugu Metropolis: Abakpa, Old Park, and New Market. Among the 30 samples analyzed, bacterial contamination varied by location, with Abakpa showing the highest prevalence at 60.0%, followed by Old Park and New Market, both at 50.0%. Non-bacterial contamination was observed in 40.0% of samples from Abakpa and 50.0% in Old Park and New Market.

**Figure 2**: Graphical representation of levels of bacterial contamination of African salad (abacha) sold in different areas of Enugu Metropolis

**4.3 Table 3: Antibiotic sensitivityof various bacteria isolates in African salad (abacha) sold in Enugu Metropolis**

|  |  |  |  |
| --- | --- | --- | --- |
| **Antibiotics**  | ***S. aureus*** **(n=8)** | ***E. coli*** **(n=3)** | ***P. aeruginosa*** **(n=5)** |
| **S** | **R** | **S** | **R** | **S** | **R** |
| Gentamicin | 7 (87.5) | 1 (12.5) | 3 (100.0) | 0 (0.0) | 3(60.0) | 2 (40.0) |
| Cloxacillin | 4 (50.0) | 4 (50.0) | 1 (33.3) | 2 (66.7) | 2 (40.0) | 3 (60.0) |
| Ceftriaxone | 2 (25.0) | 6 (75.0) | 1 (33.3) | 2 (66.7) | 1 (20.0) | 4 (80.0) |
| Ciprofloxacin | 6 (75.0) | 2 (25.0) | 3 (100.0) | 0 (0.0) | 4 (80.0) | 1 (20.0) |
| Ampicillin | 3 (37.5) | 5 (62.5) | 0 (0.0) | 3 (100.0) | 2 (40.0) | 3 (60.0) |
| Tetracycline | 2 (25.0) | 6 (75.0) | 1 (33.3) | 2 (66.7) | 1 (20.0) | 4 (80.0) |

 *S – Sensitivity; R - Resistance*

Table 3 provides an analysis of the antibiotic sensitivity and resistance patterns of bacterial isolates (*Staphylococcus aureus, Escherichia coli,* and *Pseudomonas aeruginosa*) found in African salad (abacha) sold in Enugu Metropolis. Among the antibiotics tested, Staphylococcus aureus demonstrated the highest sensitivity to Gentamicin at 87.5%, followed by Ciprofloxacin at 75.0%, indicating these antibiotics as highly effective against this bacterium. Moderate sensitivity was observed for Cloxacillin (50.0%) and Ampicillin (37.5%). However, significant resistance was noted against Ceftriaxone and Tetracycline, with both showing a resistance rate of 75.0%, suggesting these antibiotics are less effective in treating infections caused by S. aureus.

For Escherichia coli, Gentamicin and Ciprofloxacin showed complete sensitivity (100.0%), making them the most reliable treatment options. Conversely, E. coli exhibited substantial resistance to Cloxacillin and Ceftriaxone, each with resistance rates of 66.7%. Ampicillin showed complete resistance (100.0%), rendering it ineffective against E. coli. Tetracycline had a resistance rate of 66.7%, further limiting its utility in treating infections caused by this bacterium.

Pseudomonas aeruginosa exhibited moderate sensitivity to Gentamicin (60.0%) and higher sensitivity to Ciprofloxacin (80.0%), indicating these antibiotics as promising choices for treatment. However, the bacterium demonstrated high resistance to Ceftriaxone and Tetracycline, each at 80.0%, as well as substantial resistance to Cloxacillin and Ampicillin, both at 60.0%.

**Figure 3:** Graphical representation of Antibiotic sensitivity of *Staphylococcus aureus* in African salad (abacha) sold in Enugu Metropolis

 **4.4 Figure 4:** Graphical representation of Antibiotic sensitivity of *Escherichia coli* in African salad (abacha) sold in Enugu Metropolis

**Figure 5:** Graphical representation of Antibiotic sensitivity of *Pseudomonas aeruginosa*in African salad (Abacha) sold in Enugu Metropolis

1. **Discussion**

This study offers crucial insights into the bacterial contamination of African salad (Abacha), a widely consumed street food in Enugu Metropolis, Nigeria. The findings revealed that 53.3% of the Abacha samples were contaminated with bacteria, while 46.7% showed no bacterial growth. This balance indicates a need for improved food hygiene and handling practices, as over half of the samples pose potential public health risks.

The predominance of Staphylococcus aureus in 50.0% of the contaminated samples is concerning, as this organism is a well-documented cause of foodborne illnesses. Its presence in the samples strongly suggests poor hygiene during the preparation and handling of Abacha, such as improper washing of utensils, contaminated surfaces, and inadequate personal hygiene among vendors. Studies by **Anyanwu et al. (2015)** and **Obadina et al. (2014)** have similarly reported high prevalence rates of S. aureus in street-vended foods in Nigeria, emphasizing the organism's persistence in environments with substandard sanitation. Additionally, S. aureus produces heat-stable enterotoxins, which remain active even after food is reheated, potentially leading to severe food poisoning symptoms in consumers.

Pseudomonas aeruginosa, identified in 31.2% of the contaminated samples, is an opportunistic pathogen typically associated with environmental contamination. Its occurrence in Abacha may be linked to the use of contaminated water during food preparation or poor environmental sanitation in vending areas. Similar findings have been reported by **Eze et al. (2016),** who highlighted the bacterium’s presence in water and food sold in urban settings. The resilience of P. aeruginosa in diverse environments makes it a critical indicator of sanitation lapses.

Escherichia coli, isolated from 18.8% of the contaminated samples, is a key indicator of fecal contamination. Its presence suggests that the water used during preparation or the handling practices may have been compromised by fecal matter. This finding aligns with studies such as **Chukwu et al. (2017)** and **Oluwafemi and Simisaye (2014),** which underscore the risks associated with using contaminated water in food processing. E. coli can cause a range of gastrointestinal illnesses, including diarrhea, abdominal cramps, and, in severe cases, hemolytic uremic syndrome (HUS).

The variation in contamination levels across different locations—Abakpa (60.0%), Old Park (50.0%), and New Market (50.0%)—reflects the interplay between environmental sanitation, population density, and socioeconomic conditions. The higher contamination rate in Abakpa may be attributed to limited access to potable water, poor waste disposal practices, and overcrowding, consistent with observations in similar urban areas **(Oluwafemi and Simisaye, 2014).** These disparities highlight the need for tailored interventions to address the unique challenges in each area.

The antibiotic sensitivity patterns observed in this study provide additional insights into the effectiveness of commonly used antibiotics against the isolated bacteria. S. aureus showed the highest sensitivity to Gentamicin (87.5%) and Ciprofloxacin (75.0%), making these antibiotics effective options for treating infections caused by this organism. However, its high resistance to Ceftriaxone (75.0%) and Tetracycline (75.0%) is consistent with global trends of antimicrobial resistance, as noted by **WHO (2020).** These findings highlight the importance of antibiotic stewardship and the need for regular surveillance of resistance patterns.

For E. coli, complete sensitivity to Gentamicin and Ciprofloxacin suggests that these antibiotics remain highly effective. However, its complete resistance to Ampicillin and significant resistance to Ceftriaxone (66.7%) indicate emerging challenges in treating E. coli-related infections. The findings are in line with **Igbinosa et al. (2015),** who reported similar resistance patterns in foodborne pathogens, emphasizing the impact of indiscriminate antibiotic use in both human health and animal husbandry.

Pseudomonas aeruginosa demonstrated moderate sensitivity to Gentamicin (60.0%) and higher sensitivity to Ciprofloxacin (80.0%), confirming their efficacy. However, its high resistance rates to Ceftriaxone (80.0%) and Tetracycline (80.0%) align with **Nwachukwu et al. (2014),** who highlighted this pathogen's inherent resistance mechanisms, including efflux pumps and biofilm formation.

The absence of bacterial growth in 46.7% of the samples indicates that hygienic practices and proper handling can significantly reduce contamination. These findings suggest that interventions such as vendor training on hygiene, provision of clean water, and regular inspections could enhance food safety and protect public health.

The findings of this study are consistent with previous research on street-vended foods in Nigeria and other developing countries. However, the study also highlights a persistent gap in food safety practices, underscoring the need for improved regulatory frameworks, awareness campaigns, and investment in infrastructure to support food vendors. By comparing these results with existing literature, it becomes evident that a combination of education, enforcement, and community involvement is essential for mitigating the risks associated with bacterial contamination in street foods.

1. **CONCLUSION**

This study has revealed significant bacterial contamination in African salad (Abacha) sold by vendors in Enugu Metropolis, with 53.3% of the analyzed samples exhibiting bacterial growth. The predominant isolates, Staphylococcus aureus, Pseudomonas aeruginosa, and Escherichia coli, underscore concerns over hygiene and handling practices. These bacteria are known to cause foodborne illnesses and opportunistic infections, posing health risks to consumers.

The variation in contamination levels across different locations further highlights the role of environmental and socioeconomic factors in influencing food safety. While 46.7% of the samples showed no bacterial growth, suggesting good hygienic practices by some vendors, the presence of antibiotic-resistant strains in the contaminated samples signals a growing public health challenge.

These findings emphasize the urgent need for improved hygiene during food preparation, stricter regulatory oversight of street foods, and public health education to reduce bacterial contamination and safeguard consumers.

**REFERENCES**

Adebayo-Tayo, B.C., and Odu, N.N., 2017. Microbiological analysis of street-vended foods: a focus on Abacha in urban Nigeria. *African Journal of Biotechnology,* 16(30), 1784-1791.

Adeyemi, T.E., and Adebayo, K., 2019. Temperature control and microbial contamination of street-vended African salad (Abacha) in Southeastern Nigeria. *Journal of Food Quality and Safety,* 13(2), 98-106.

Anozie, O.C., Obi, C. and Nworie, O., 2020. Microbial contamination of ready-to-eat foods sold in Nigeria: A case study of Abacha. African Journal of Microbiology Research, 14(9), .456-463.

Anyanwu, B.N., 2014. Health implications of bacterial contamination in ready-to-eat foods sold in Nigeria. *Journal of Food Safety and Hygiene*, 10(1), 45-52

Chukwu, O.O.C., Eze, V.C., and Igwe, U., 2015. Bacterial contamination of locally prepared condiments and spices in Enugu Metropolis. African Journal of Food Science, 9(4), 120-126.

Eze, V.C. and Ivuoma, N., 2016. Evaluation of microbial quality of fresh meats sold in Abattoirs in South-Eastern Nigeria. Journal of Food Microbiology, 8(3), .32-39.

Eziuzo, N.C., and Mbachu, J.C., 2021. Risk assessment of bacterial load in street foods: A case study of Abacha in Enugu State. *Nigerian Journal of Microbial Studies,* 10(1), 34-40

Food and Agriculture Organization (FAO), 2020. Street food in urban Africa: safety and nutritional value.

Igbinosa, E.O. and Okoh, A.I., 2013. Emerging Vibrio species: potential health implications for urban communities. Research in Microbiology, 164(2), 156-164.

Iheanacho, C.C. and Obi, U.C., 2021. Assessment of bacterial contamination and antibiotic resistance in street-vended foods in Enugu, Nigeria. International Journal of Food Microbiology, 312, 108396.

Nnadi, O.C., and Ezemba, I.N., 2023. Influence of vendor training on microbiological safety of African salad sold in Nigeria. *Journal of Foodborne Pathogens and Public Health,* 18(3), .145-157.

Nwachukwu, E., Orji, F.A., and Ijioma, F., 2015. Safety assessment of ready-to-eat foods (RTE) sold in Umuahia Metropolis, Abia State, Nigeria. Nigerian Journal of Microbiology, 29(2), 1230-1235.

Ogunsanya, C., and Okoro, O.E., 2019. Antibiotic resistance in foodborne pathogens isolated from street-vended African salad in Nigeria. *Journal of Medical Microbiology Research,* 10(4), 260-268.

Okeke, C.O., and Lamikanra, A.O., 2018. Foodborne illnesses associated with bacterial contamination in urban Nigeria. *International Journal of Food Microbiology,* 265, 12-19

Oluwafemi, F. and Oluwaseun, M.T., 2014. Microbial contamination and antibiotic resistance in drinking water sachets in South-Western Nigeria. Journal of Applied Microbiology and Biotechnology, 5(3), 78-83.

Omotayo, R., and Omole, B., 2021. Street food contamination and its health risks in Nigerian urban centers. *Global Food Hygiene Research Journal,* 5(1), 89-98

Oranusi, U., Braide, W. and Esiobu, N., 2013. Microbiological and chemical quality assessment of some commercially packed fruit juices sold in Nigeria. Nigerian Journal of Microbiology, 27(1), 2767-2775.

World Health Organization (WHO), 2015. Estimates of the global burden of foodborne diseases: Foodborne Disease Burden Epidemiology Reference Group 2007-2015.