



IDENTIFICATION AND ISOLATION OF BACTERIA FROM FOODS AND VEGETABLES AVAILABLE AT NKWO-OGIDI MARKET, ANAMBRA STATE

***¹Onuora Ifeoma Joy, ¹Obi - Ezeani Chikaodili Nwando, ¹Umedum Chinelo Ursula, ¹Onyeizugbe Chidi Mmaduabuchi, ¹Nnoruka Eugenia Obiageli, ²Obi Collins Uchechukwu**

¹Department of Medical Laboratory Science, Chukwuemeka Odumegwu Ojukwu University Igbariam, Anambra State.

²Department of Chemical Pathology, Faculty of Medical Laboratory Sciences, Nnamdi Azikiwe University, Nnewi Campus, Anambra State.

Article Info

Article Received: 21 March 2025,
 Article Revised: 10 April 2025,
 Published on: 01 May 2025.



*Corresponding author:

Onuora Ifeoma Joy
 Department of Medical Laboratory
 Science, Chukwuemeka Odumegwu
 Ojukwu University Igbariam,
 Anambra State.
ifeomajoyonuorah@gmail.com

ABSTRACT

Background: Bacterial contamination of ready-to-eat foods and fresh vegetables poses a significant public health risk, particularly in markets with suboptimal hygiene practices. **Aims:** This study aimed to investigate bacterial contamination in ready-to-eat foods and green leafy vegetables sold at Nkwo Ogidi Market, Anambra State, Nigeria. **Methodology:** A total of 40 food samples (Rice, Beans, Egusi Soup, Moi Moi, and Oha Soup) and 37 vegetable samples (Pumpkin, Scent Leaf, Curry Leaf, Water Leaf, and Spinach) were collected. **Results:** After incubation, bacterial contamination was observed in 34 (85%) of the food samples and 34 (81.1%) of the vegetable samples. Scent leaf vegetables had the highest contamination rate (26.7%), while Beans and Oha Soup had the highest contamination rates among the foods (26.6%). *Escherichia coli* (36.6%) was the most common bacterial isolate in the vegetables, particularly in scent leaf, while *Pseudomonas* species (35.3%) were the most prevalent in the ready-to-eat foods, especially beans and oha Soup. A chi-square test of independence revealed no significant association between food type and bacterial contamination ($\chi^2=12$, $df = 20.5$, $P = 0.059$). However, a statistically significant relationship was found between vegetable type and bacterial contamination ($\chi^2 = 20$, $df = 57.7$, $P = 0.000$). **Conclusion:** The study highlights significant bacterial contamination in commonly consumed food and vegetables, emphasizing the need for improved hygienic practices to mitigate public health risks.

KEYWORDS: Bacterial contamination, ready-to-eat foods, green leafy vegetables, public health, Nkwo Ogidi Market, hygiene practices.

INTRODUCTION

Food safety remains a critical public health concern globally, particularly in developing countries where poor hygiene, inadequate food handling practices, and limited regulatory oversight can contribute significantly to foodborne illnesses.^[1] Markets such as Nkwo-Ogidi in Anambra State, Nigeria, are major sources of ready-to-eat foods and fresh vegetables, which are essential to daily nutrition. However, these food items are often exposed to various environmental contaminants, increasing the risk of microbial contamination. Moreover, food products are at risk of contamination with mishandling during processing and preparation, where there are favorable conditions for pathogens.^[2]

Vegetables, especially leafy greens, are commonly consumed raw or lightly cooked, making them potential carriers of pathogenic microorganisms when not properly handled or washed.^[3] Similarly, ready-to-eat foods sold by

vendors in open markets are susceptible to contamination from air, water, food handlers, and unclean utensils.^[4] Bacterial contaminations of these food sources pose a significant health risk, especially to immunocompromised individuals, children, and the elderly.

Several studies have identified pathogenic bacteria such as *Escherichia coli*, *Salmonella* spp., *Staphylococcus aureus*, and *Pseudomonas* spp. in foods and vegetables sold in local markets. These organisms are known to cause a variety of infections ranging from mild gastroenteritis to severe systemic illnesses. Monitoring and evaluating the microbial quality of foods and vegetables is therefore essential to ensuring public health safety.^[5,6,7]

Despite the growing awareness of microbial hazards in food, limited research has been conducted to assess bacterial contamination in foods and vegetables at Nkwo-Ogidi Market. This study seeks to bridge this research gap

by investigating the prevalence and types of bacterial contaminants in foods and green vegetables from the market. By identifying and isolating bacteria from these food items, this research seeks to provide valuable insights into the microbiological safety of food available at this market. The findings will contribute to a better understanding of the potential public health risks associated with food consumption in the region and inform strategies for improving food safety practices. This research is essential for ensuring the health and well-being of the community relying on the Nkwo-Ogidi market for their food supply.

This study aims to identify and isolate bacterial species present in selected ready-to-eat foods and green leafy vegetables sold at Nkwo-Ogidi Market, intending to assess the extent of contamination and provide data that could inform food safety practices in the region.

MATERIALS AND METHODS

Study Design and Location

This study employed a cross-sectional descriptive design to identify and isolate bacterial species present in ready-to-eat foods and fresh leafy vegetables sold at Nkwo-Ogidi Market, located in Idemili North Local Government Area, Anambra State, Nigeria. The market is a major commercial hub known for the open sale of various cooked foods and raw vegetables. The study population comprised food vendors and vegetable sellers within the market premises.

Sample Collection

A total of seventy-seven (77) samples were collected during the study period, including forty (40) ready-to-eat food samples—such as rice, beans, moi moi, egusi soup, and oha soup—and thirty-seven (37) fresh vegetable samples—such as pumpkin leaves, scent leaves, curry leaves, water leaves, and spinach. Samples were randomly selected from diverse vendors and stalls across different sections of the market to ensure wide representation.

Each sample was aseptically collected in sterile containers and transported in ice-packed coolers to the microbiology laboratory. All samples were processed within two hours of collection to preserve microbial viability.

Inclusion and Exclusion Criteria

The inclusion criteria consisted of ready-to-eat foods displayed for public consumption and fresh, unpackaged leafy vegetables. Excluded from the study were:

- Pre-packaged or processed food items
- Stale or visibly spoiled food and vegetables
- Vegetables that had been washed or stored in sealed containers

Ethical Considerations

Although no human subjects were directly involved, verbal consent was obtained from all vendors before sample collection. Ethical clearance was granted by the Iyi-Enu Research Ethics Committee.

Sample Processing and Bacterial Isolation

Food samples were homogenized, while vegetable samples were rinsed and weighed. Ten grams (10 g) of each sample were aseptically transferred into sterile saline solution and serially diluted.^[8] Aliquots of the diluted samples were inoculated onto various selective and differential culture media, including nutrient agar, MacConkey agar, mannitol salt agar, and Salmonella-Shigella (SS) agar. All plates were incubated aerobically at 37°C for 24 to 48 hours.

Distinct colonies observed on the culture media were subcultured to obtain pure isolates and subsequently subjected to identification procedures. The bacterial isolates were identified following the Manual of Systematic Bacteriology^[9] (Clausen and Berkeley, 1986). The morphology of the isolated bacteria was examined following Gram's staining and on the basis of some biochemical test viz., Methyl Red and Catalase test^[10] (Cappuccino and Sherman, 2005).

Bacterial Identification

Isolated colonies were initially characterized by Gram staining and further identified using a series of standard biochemical tests, including catalase, coagulase, oxidase, indole production, citrate utilization, and sugar fermentation assays. Identification to the genus or species level was based on established microbiological protocols.^[11]

Data Collection and Quality Control

Observations on bacterial growth, colony morphology, and biochemical profiles were systematically documented. The number and types of bacteria isolated from each food and vegetable sample were recorded. In addition, observations regarding vendor hygiene practices—such as cleanliness of utensils, use of protective gear, and general sanitation—were noted to assess potential contamination sources.

To ensure reliability and reduce bias:

- Samples were collected across a diverse range of vendors and locations within the market.
- Selected samples underwent duplicate analysis for consistency.
- Laboratory personnel were blinded to the identity and origin of the samples during processing and identification.

Data Analysis

All recorded data were entered into the Statistical Package for Social Sciences (SPSS), version 25. Descriptive statistics were used to determine the frequency and percentage of bacterial isolates across the different sample categories. Inferential statistics, specifically chi-square tests, were applied to evaluate associations between contamination rates and sample types. A p-value of less than 0.05 was considered statistically significant.

Study Limitations

The study focused exclusively on aerobic bacterial isolates; fungi and anaerobic organisms were not assessed due to

resource limitations. Additionally, only one market location was studied, which may restrict the generalizability of the findings to other areas. Molecular methods for bacterial identification were not employed, and all identifications relied on conventional microbiological techniques.

RESULT

A total of 40 different food samples—Rice, Beans, Egusi Soup, Moi Moi, and Oha Soup—were collected from various food vendors at Nkwo Ogidi Market. Additionally, 37 samples of green leafy vegetables, including pumpkin, scent leaf, curry leaf, water leaf, and spinach, were obtained from the same location. After overnight incubation, bacterial contamination was observed in 34 (85%) of the food samples. Similarly, 34 (81.1%) of the vegetable samples were found to harbor bacterial isolates, as presented in Table 1 and Fig 1.

Furthermore, bacterial contamination was highest in scent leaf vegetables, accounting for 26.7% of the total contaminated vegetable samples. Among the ready-to-eat foods, Beans and Oha Soup recorded the highest contamination rates, each with 26.6%, as illustrated in

Figures 2 and 3. The most prevalent bacterial isolate from the vegetables was *Escherichia coli* (36.6%), with the highest occurrence observed in scent leaf (5 isolates). Conversely, *Pseudomonas* species were most frequently found in the ready-to-eat food samples (35.3%), with beans and Oha Soup exhibiting the highest number of isolates at 26.6% (9 isolates), as illustrated in Figures 4 and 5 and Tables 2 and 3.

A chi-square test of independence was conducted to examine the relationship between food type and bacterial contamination. The result was not statistically significant, $\chi^2 = 12$, $df = 20.5$, $P = 0.059$, indicating that bacterial contamination was not significantly associated with specific food types.

Conversely, a chi-square test of independence examining the relationship between vegetable type and bacterial contamination revealed a statistically significant association, $\chi^2 = 20$, $df = 57.7$, $P = 0.000$. This suggests that certain vegetable types were more likely to be contaminated with specific bacterial species.

Table 1: Percentage of bacteria isolated from food and vegetables sold at nkwo ogidi market.

S/N	Source	Samples	Total number of samples with isolates	Total number of samples without isolates	Total number of samples
1	VEGETABLES	pumpkin, scent leaf, curry leaf, water leaf and Spinach	30(81.1%)	7(18.9%)	37(100%)
2.	READY -TO-EAT FOOD	Rice, Beans, Egusi Soup, Moi Moi and Oha Soup	34(85%)	6(15%)	40(100%)
			Total number of sample with isolates = 64(83.1%)	Total number of samples without isolates = 13(16.9%)	Total number of samples = 77(100%)

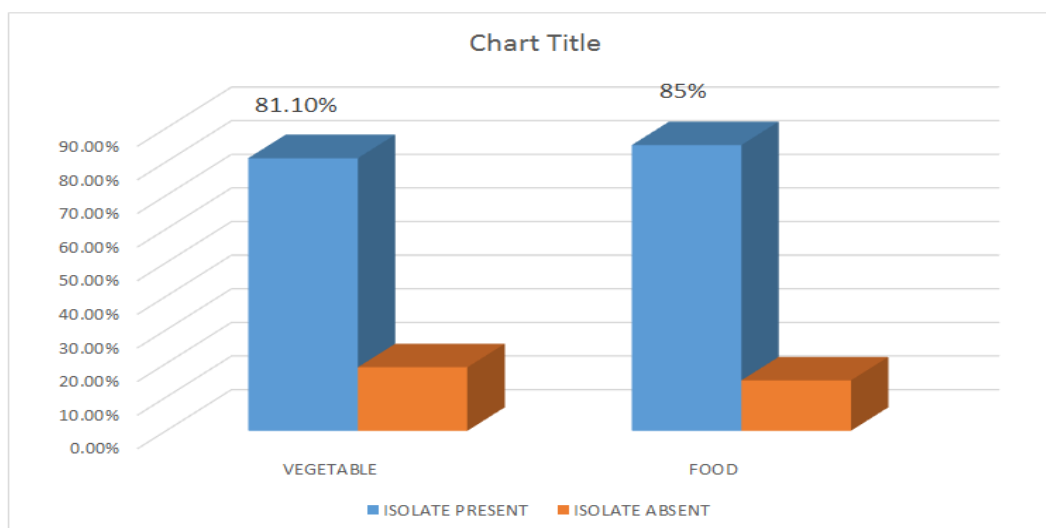


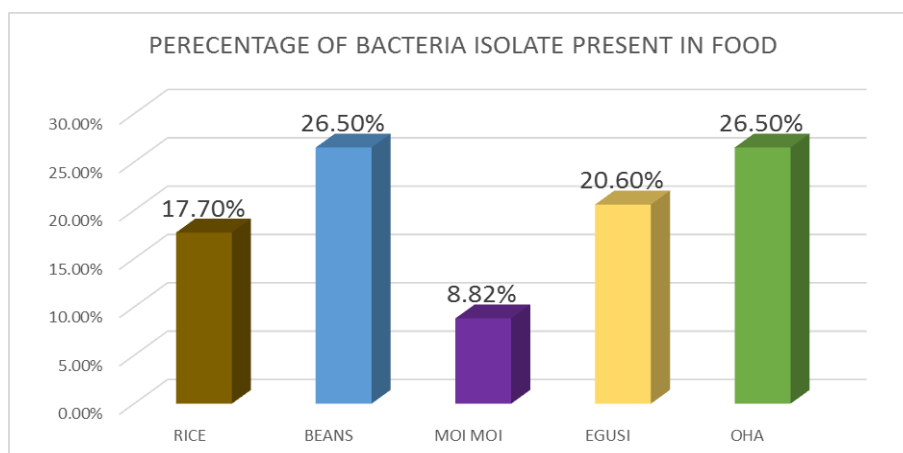
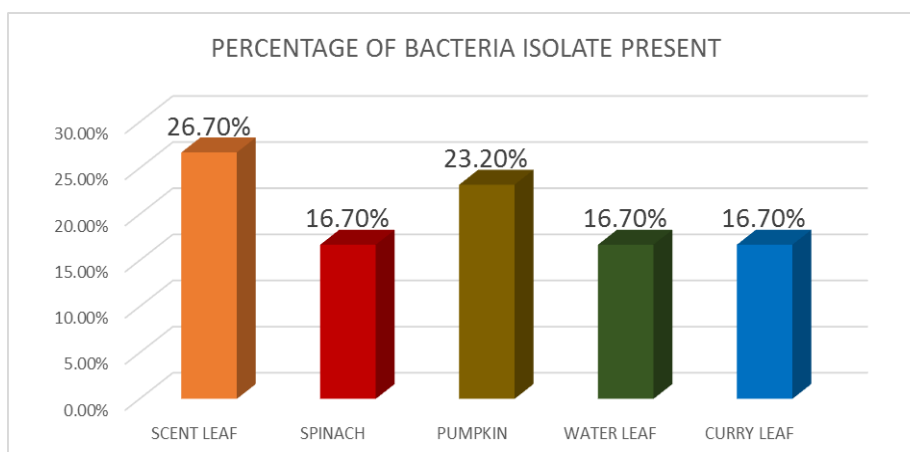
Figure 1: Percentage of bacteria contaminants in food and vegetables sold at nkwo ogidi market.

Table 2: Different bacteria isolates from food obtained from the different food vendors.

Sample	Total number of Pseudomonas isolates	Total number of E. coli isolates	Total number of Klebsiella isolates	Total number of Salmonella isolates	Total number of isolates
Rice	2	3	0	1	6(17.7%)
Beans	3	3	0	3	9(26.5%)
Moi- Moi	0	1	2	0	3(8.82%)
Egusi soup	5	2	0	0	7(20.6%)
Oha soup	2	1	3	3	9(26.5%)
Total Number of isolates = 34	Total number of Pseudomonas s isolates = 12(35.3%)	Total number of E.coli isolates = 10(29.4%)	Total number of Klebsiella isolates: = 6(17.65%)	Total number of Salmonella isolates = 6(17.65%)	34(100%)

Table 3: Different bacteria isolated from the different vegetable samples.

Sample	Total number of Pseudomonas s isolates	Total number of E. coli isolates	Total number of Klebsiella isolates	Total number of Salmonella isolates	Total number of isolates
Scent leaf	2	5	0	1	8 (26.7%)
Spinach	0	0	2	3	5(16.7%)
Pumpkin leaf	2	3	2	0	7(23.2%)
Water leaf	3	2	0	0	5(16.7%)
Curry	2	1	0	2	5(16.7%)
Total Number of isolate = 30	Total number of Pseudomonas s isolates = 9(30%)	Total number of E.coli isolates = 11(36.6%)	Total number of Klebsiella isolates = 4(13.3%)	Total number of Salmonella isolates = 6(20%)	30(100%)

**Figure 2: Percentage of bacteria contaminants from different foods obtained.****Figure 3: Percentage of bacteria contaminants in different vegetables sold at nkwo ogidi market.**

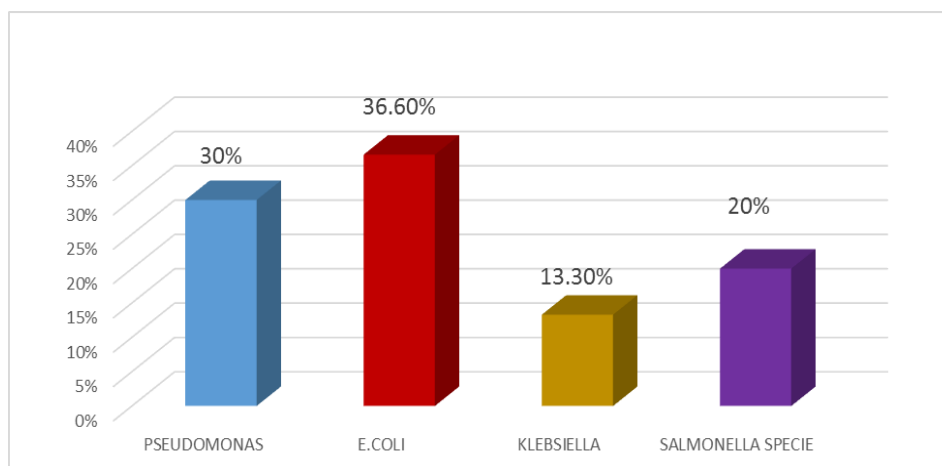


Figure 4: Percentage of different bacteria isolated from vegetables sold at nkwo ogidi market.

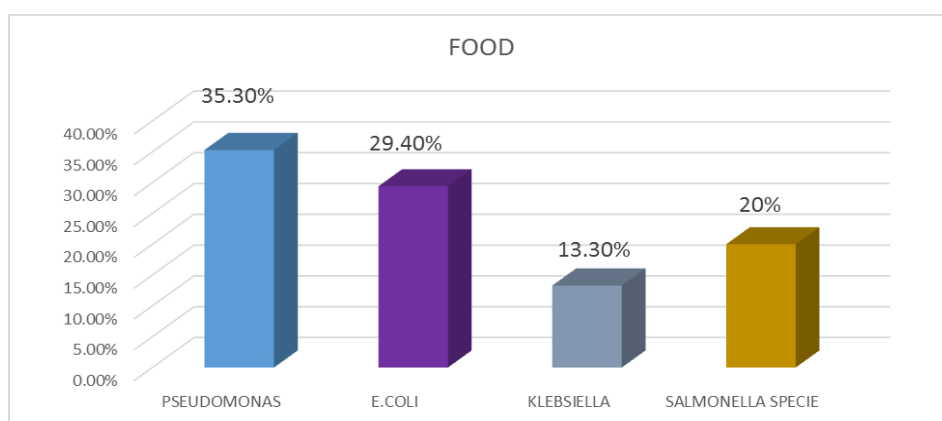


Figure 5: Different bacteria isolates from food obtained from the different food vendors.

DISCUSSION

This study highlights the significant public health risks associated with bacterial contamination in foods and vegetables sold at Nkwo-Ogidi Market, with contamination rates of 85% in food samples and 81.1% in vegetable samples. The high prevalence of contamination is consistent with findings from similar studies in developing regions.^[12,13,14] The findings of this study align with previous research by Shoba et al., which revealed that improper handling of produce—ranging from harvesting and storage to processing and distribution—contributes significantly to the bacteriological contamination of vegetables.^[5]

The detection of *Escherichia coli* as the most prevalent bacterial contaminant in vegetables, particularly scent leaf, suggests fecal contamination due to unsanitary irrigation water or improper handling.^[15] This finding is in line with work done by Favour et al., and Paul et al., who also observed *E. coli* to be the most predominant bacteria isolated from vegetables.^[15, 16] The broad surface area of leafy vegetables like scent leaf may increase their susceptibility to retaining contaminants.

Furthermore, this study identified a statistically significant association between vegetable type and bacterial contamination, underscoring the influence of vegetable

characteristics on contamination risks.^[12,13,14] Leafy vegetables' close contact with soil and environmental exposure make them more vulnerable than other produce types.^[17] In contrast, the lack of a significant association between food type and bacterial contamination may reflect variations in food handling and preparation practices, such as cooking methods that reduce bacterial loads but fail to prevent post-cooking contamination. Several factors contribute to the contamination of street foods: cross-contamination via utensils; unsanitary vending sites; the use of potentially contaminated tap water in food preparation; improper disposal of waste, attracting disease-carrying rodents and insects; sporadic fly contamination; and unhygienic handling by vendors using bare hands. Ready-to-eat street foods are also susceptible to cross-contamination from utensils, knives, raw ingredients, flies, vendors' bare hands during serving, and occasional consumer handling.^[16] At many vending sites, tap water for handwashing and utensil cleaning is often unavailable. Consequently, washing is typically done in one or more buckets, sometimes without soap. Furthermore, toilets, proper waste disposal, and refrigeration facilities are rarely present. This leads to wastewater and garbage being discarded nearby, creating a nutrient-rich environment for insects and rodents that can transmit foodborne pathogens.^[16, 19]

The prevalence of *Pseudomonas* in ready-to-eat foods, especially in beans and oha soup, points to issues with storage and post-cooking contamination. These findings align with studies reporting high bacterial contamination rates in informal food markets due to environmental conditions and inadequate hygiene practices.^[4,16] Our finding of *Pseudomonas* as the most common bacterium in food samples differs from the results of Akilan et al. and Paul et al., who found *Escherichia coli* to be more prevalent in their food sample analyses. These discrepancies could be attributed to variations in bacterial detection methods, the number of samples examined, and the specific practices of the food vendors involved in each study. The study's limitations, including convenience sampling and the absence of bacterial load and antibiotic resistance analysis, may restrict the generalizability of findings. Future research should adopt rigorous sampling methods, investigate antibiotic resistance profiles, and assess bacterial loads to provide a comprehensive understanding of food safety in Nkwo-Ogidi Market. Public health interventions targeting hygiene practices among vendors and consumers, alongside improved food safety regulations, are crucial for mitigating contamination risks and safeguarding community health.

CONCLUSION

This study reinforces the need for improved hygiene practices in markets, particularly for vendors handling ready-to-eat foods and fresh vegetables. The high contamination rates found in this study highlight the potential public health risks associated with poor food safety practices in Nkwo Ogidi Market. The significant association between vegetable type and bacterial contamination underscores the importance of properly handling and storing fresh produce to minimize the risk of foodborne diseases. Further studies incorporating molecular methods and broader geographical sampling could provide more comprehensive insights into the dynamics of foodborne bacterial contamination in Nigeria.

REFERENCES

- Hemalata VB, and Virupakshaiah DBM. Isolation and Identification of foodborne pathogens from Spoiled food samples. *Int. J. Curr. Microbiol. App. Sci.* 2016; 5(6): 1017-1025.
- Kim A, Park S, Hong Y, Shin J, Joo S. Isolation and Characterization of Beneficial Bacteria from Food Process Wastes. *Microorganism.* 2021; 9(6): 1156.
- Okafor PN. Isolation and identification of Bacteriological constituents of some Leafy Vegetables Sold in Rural Markets in Anambra State, Nigeria. *Int. J. Adv. Res.* 2022; 10(02): 845-851.
- Akilan AK, Sundaravalli R, Devi R. Isolation and identification of Pathogenic Bacteria from Street Foods in Chennai. *Annals of R.S.C.B.*, 2020; 24(1): 609- 613.
- Shobha, S. Bacteriological analysis of Fresh vegetables and Fruits of local market and effect of Pretreatment by Antimicrobial agents on their quality. *International Research Journal of Biological Sciences Int. Res. J. Biological Sci*, 2014; 3(11).
- Muhammad SA, Ani AS. & Nasiru AM. Isolation and Identification of Bacteria Responsible for the Spoilage of Fluted Pumpkin (*Telfaria occidentalis*) and Bitter Leaf (*Vernonia amygdalina*) in Sokoto Metropolis. EPRA. *International Journal of Multidisciplinary Research (IJMR)*. 2021 <https://doi.org/10.36713/epra4997>
- Devi D and Bordolo R. Isolation and identification of fungi and bacteria from some spoiled fruits and vegetables. *Plant Archives*. 2021; 21(1): 1550-1553.
- Ruangpan, L., & Tendencia, E. (2004). Bacterial isolation, identification, and storage. In *Laboratory Manual of Standardized Methods for Antimicrobial Sensitivity Tests for Bacteria Isolated from Aquatic Animals and Environment*, 330.
- Clauss D. and Berkeley RCW. Genus *Bacillus* Cohn 1872. In *Bergey's manual of determinative bacteriology*, Sneath, P H A, Baltimore. MD: Williams Wilkins, 1986; 2: 1105-1141.
- Cappuccino JG. and Sherman N. *Microbiology: A Laboratory Manual*, seventh ed. Pearson Education. Inc. and Darling Kindersley (India) 2005 143- 203.
- Cheesbrough, M. District laboratory practice in tropical countries. In *District Laboratory Practice in Tropical Countries*. 2025 <https://doi.org/10.1017/CBO9780511581304>
- Ajayi OO, Balogun O, Dada OE, and Ajidahun V. Isolation of Microbial Contaminants from Vegetables. *JABU Journal of Science and Technology* 2016; 2:4 78-88.
- Chaudhary L and Dhaka TS. Isolation and identification of bacteria from some spoiled vegetables. *Biochem. Cell. Arch.* 2016; 16(2): 343-345.
- Biswas B, Azad AK, Absar N, Islam S, Amin S. Isolation and Identification of Pathogenic Bacteria from Fresh Fruits and Vegetables in Chittagong, Bangladesh. *Journal of Microbiology Research* 2020; 10(2): 55-58.
- Favour BA, Ulim-Ujuo-Ushang IK, and Adaeze CN. Isolation and Identification of Microorganisms from Some Spoiled Fruits and Vegetables Sold within the Federal Polytechnic of Oil and Gas, Bonny Island, Rivers State. *Research Journal of Food Science and Quality Control* 2024 10(4): 1-9.
- Paul TK, Roy SR, Sarkar PR, Tarafder M and Saha TK. Isolation and identification of bacteria in different street-vended foods collected from selected areas of Bangladesh. *Asian Australas. J. Food Saf. Secur.* 2018; 2(2): 65-70.
- Raja, M. M., A. Raja, M. S. Hajee and S. A. Mohamed Screening of bacterial compost from spoiled vegetables and fruits and their physicochemical characterization. *International Food Research Journal*, 2021; 19(3): 1193-1198.
- Tambekar, D. H., Jaiswal, V. J., Dhanorkar, D. V., Gulhane, P. B., Dudhane, M. N. Microbial quality and safety of street vended fruit juices: a case study of Amravati city. 2009. *Internet J. Food Safety*, 10: 72-76.

19. Hassan MS, Kabir SML, Sarker YA and Rahman T. Bacteriological assessment of tap water collected from different markets of Mymensingh, Gazipur and Sherpur districts of Bangladesh with special focus on the molecular detection and antimicrobial resistance of the isolated *Escherichia coli*. *Asian Australas J. Food Saf. Secur.*, 2018; 2: 21-28.
20. Zeighami H, Nejad-dost G, Parsadanians A, Daneshamouz, S, & Haghi F. Frequency of hemolysin BL and non-hemolytic enterotoxin complex genes of *Bacillus cereus* in raw and cooked meat samples in Zanjan, Iran. *Toxicology Reports*, 7. 2020. <https://doi.org/10.1016/j.toxrep.2019.12.006>