

Knowledge of Food Safety and Farm-to-Market Preservation Practices as Determinants of Antimicrobial Resistant and Virulence Genes in *Listeria* species in Vegetables in Nigeria

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ABSTRACT

Background: In Nigeria, vegetables are often prone to contamination that leads to food-borne disease with significant public health and economic burdens such as listeriosis. Persistence of such contamination could be due to inadequate hygienic practices and poor handling which affect food safety, quality, and security. Limited empirical data on antimicrobial resistance patterns and virulence gene profiles of *Listeria* species in vegetables create gap in evidence needed for effective surveillance and control strategies.

Objective: This study assessed detection and prevalence of antimicrobial resistance patterns, and virulence gene profiles of *Listeria monocytogenes* with other *Listeria* species in vegetables obtained from selected Nigerian markets.

Methods: A cross-sectional study was conducted on 270 vegetable samples comprising cucumber (n = 90), cabbage (n = 90), and carrot (n = 90), obtained from 30 markets across selected Nigerian states. Samples were collected directly from farmers' vendors, and analyzed for presence of *Listeria* species using standard microbiological and molecular techniques. Antimicrobial susceptibility testing was performed against 15 antibiotics using the disk diffusion method. Polymerase chain reaction (PCR) assays were used to detect 18 antimicrobial resistance genes and 9 virulence-associated genes in the isolates.

Results: Antimicrobial resistance genes were identified across *Listeria* species. *Listeria monocytogenes* showed resistance to chloramphenicol, aminoglycosides, and vancomycin; *L. ivanovii* to carbapenems; *L. seeligeri* to chloramphenicol, aminoglycosides, tetracycline, and vancomycin; *L. innocua* to macrolides, vancomycin, and fluoroquinolones; and *L. grayi* to macrolides, vancomycin, aminoglycosides, and chloramphenicol. Virulence genes (*prs*, *hlyA*, *clpE*, *plcA*, *prfA*, *iniB*, *actA*, *RADP*) were detected in *L. monocytogenes* from cabbage samples in Agege (77.78%) and Oshodi (44.44%) markets, except *plcB*. *L. grayi* exhibited all assessed virulence genes in cabbage and carrot samples.

Conclusions: This study concludes that there was presence of six strains of *Listeria* spp (including *Listeria monocytogenes*) in the vegetable with antimicrobial resistance and virulent genes, which might be due to consequences of cross-contamination, along farm-market supply chain. Handlers must thereby ensure good production, hygienic handling, and practices from farm to plate.

Unique contributions: This study provides novel insights into detection and prevalence of antimicrobial resistance, and virulence profiles of *Listeria monocytogenes* and other *Listeria* species in fresh vegetables across Nigerian markets. It highlights the presence of hypervirulent and multidrug-resistant strains in commonly consumed vegetables, demonstrating environmental contamination in Osun State and high virulence potential in Ondo State. These findings offer critical evidence for understanding microbial safety of vegetables in Nigeria and emphasized on the need for targeted surveillance and improved handling practices along farm-to-market supply chain.

Key Recommendation: To mitigate the risk of listeriosis from fresh vegetables, it is recommended that hygienic handling practices and proper storage be enforced along the farm-to-market supply chain. Regular surveillance and monitoring of *Listeria* contamination, coupled with adherence to food safety standards, are essential to reduce the prevalence of multidrug-resistant and virulent strains in commonly consumed vegetables.

Keywords: *Listeria* spp, antimicrobial resistance genes, virulence genes, fresh vegetables, listeriosis

INTRODUCTION

Listeriosis infection is one of the Neglected Tropical Diseases (NTDs) that are under-reported, under-noticeable or under diagnosed disease among healthy women in Nigeria, but its fatality is high in neonates, babies and pregnant women (Irshad *et al.*, 2023). According to the report from The End Fund (2023), 84% of Nigerians need urgent treatment of NTDs because only 17% do employ improved microbial safety practices (WHO, 2026). Listeriosis could be found in healthy individual, however occurrence persists in Nigeria with regular miscarriage, influenza-like meningoencephalitis as well as meningitis (in pregnant women, neonates, or other vulnerable individuals) (Olise and Okpor, 2025). It could be caused by high risk contaminated vegetables with *Listeria monocytogenes* and other species, coupled with unsafe vegetable handling (WHO, 2018). *Listeria monocytogenes* infection was found in Africa, but 13.6% of 147 people know about listeriosis, when more women suffer from constant miscarriage (Sarr *et al.*, 2023). In year 2023, NAFDAC recovered about 3300 kg of *Listeria spp* contaminated frozen mixed vegetable products in Port-Harcourt and Abuja (NAFDAC, 2023). The degree of prevention of listeriosis in Nigeria could be measure of prevalence outcome (Suleiman *et al.*, 2016).

Vegetables are most available nutritious and healthy foods (consumed with peels or directly placed in the mouth with the peels) in Nigeria. Among these foods are cucumber, cabbage, carrot and so on. *Listeria* contamination of these foods could easily promote lethal infections and regional listeriosis outbreaks (WHO, 2024). Knowledge about good handling method of vegetables and proper human antimicrobial therapy to cure the diseases, coupled with best approach to meet high demand for vegetables is needed. Unfortunately, *Listeria* contamination in vegetable is becoming articulated in Africa, due to more virulence genes with antimicrobial resistance, posing more danger to consumers' health (Dufailu *et al.*, 2021). Recently, Pekoula *et al* (2025) reported some virulence genes in *Listeria monocytogenes*, *L. innocua* and *Listeria ivanovii* from fresh vegetables sold in Abidjan markets, denoting that their presence signify threat to the public health. But in this study, data about the prevalence of six strains of *Listeria* contamination, their virulence genes in relation to antimicrobial resistance genes in Nigerian vegetables were focused on.

Recently, there are decreasing trend in global lethal infections linked with vegetables (showing about 74.63% reduction compared to that of year 2017 with 6.7 million people estimation). This was a reflection of rising in prevalence study, awareness, nutritional cognizance, health-linked recommendations and consumption patterns of vegetables as well as knowledge about related diseases, with good production and supply practices (WHO, 2024; WHO, 2023). Meanwhile, listeriosis infection and intervention in Nigeria are still at embryonic stage.

Farmers' vendors could employ effective means to make vegetables available for all via the use of irrigating farming, green houses, supermarkets and spoilage prevention methods, but other neglected factors limit them from rendering them safely. Such factors are tough dry season, improper disposal of waste, flooding, faeces or sewage contaminated soil, wastes from antibiotics-treated animals, contaminated industrial effluent, natural cross-contamination, far distance to and small size of supply site, contact with other perishable foods, lack of good water supply, as well as inadequate toilet or drainage availability may be barriers to have safe and quality vegetable supply.

WHO (2018) highlighted the guideline to reduce to minimal listeriosis infections that mainly focus on consuming *Listeria*-free foods. This study is important because despite the preventive measure from farms-market level, death-leading listeriosis incidence and outbreaks are linked to

multidrug resistance. Studies on multiple virulent and resistant genes from *Listeria* strains could be determined for preventive or controlling measures, which may enhance security and safety of vegetables in Nigeria. Meanwhile, prevention measures for resistant and toxigenic or virulent *Listeria* hazard in vegetables are necessary and urgent, but there are few empirical data on the antimicrobial resistance patterns and virulence gene profiles of *Listeria* species in vegetables in Nigeria.

The aims of this study were to detect the presence of *Listeria monocytogenes* and other *Listeria* species with their virulence genes in vegetables obtained from selected Nigerian markets, across several states. The research further determines antimicrobial resistance patterns in the isolates, which gives ability to resist antibiotic treatment, when they cause listeriosis.

MATERIALS AND METHODS

Study area and Samples collection

A cross-sectional study was conducted on 270 vegetable samples comprising cucumber (n = 90), cabbage (n = 90), and carrot (n = 90), obtained from 30 markets across Lagos, Osun and Ondo States, between September 2021 and August 2022 (Table 1). Samples were collected directly from 90 farmers' vendors and transported to Nigerian Institute of Medical Research, Lagos, for analysis.

***Listeria* spp Isolation**

Presence of *Listeria* species were done using PHE (2017) which involved serial dilution of vegetable samples in Half-Fraser Broth and Full-Fraser Broth (OXOID, CM0895 ISO, United Kingdom) as well as isolation and enumeration on Palcam Agar (Oxoid, CM0877) and *Listeria* Selective Agar Base (Oxford Formulation, CM0856). At 37 °C and 24-48 h incubation conditions, isolates were cultured, purified and then stored in slants, at 4 °C for further microbial assessment.

Phenotypic Identification

Suspected isolates were characterized using Microbact *Listeria* 12L Identification System, MB11B1, Oxoid Limited, UK. Pure isolates smeared and heat-fixed on slides were gram-stained and examined under an oil immersion microscope (Dubey, 2014). Catalase test of isolates (Kanganwiro, 2015) was observed in bubbles with drop of hydrogen peroxide (3%) whereas oxidase test (Ali *et al.*, 2017) was performed with strip moistened with tetramethyl-p-phenylenediaminedihydrochloride, bringing out a violet or purple colour in 10 min.

Antimicrobial Susceptibility Test

Antimicrobial susceptibility testing of isolates was performed against 15 antibiotics: amoxillin-clavulanic (30 µg), tetracycline (30 µg), ciprofloxacin (5 µg), imipenem (10 µg), ampicillin (10 µg), erythromycin (15 µg), azithromycin (15 µg), trimethoprim-sulphanamide (25 µg), gentamycin (10 µg), streptomycin (30 µg), chloramphenicol (30 µg), cefotaxone (30 µg), ceftriazone (30 µg), vancomycin (5 µg), clindamycin (2 µg); using Kirby Bauer disk diffusion method. Zones of inhibition were measured in millimeter and then compared with Clinical and Laboratory Standards Institute (CLSI, 2021).

Genotype Characterization

DNA Extraction

DNA extraction was first done using boiling or conventional method (Mthembu *et al.*, 2019). This involved 1 ml of sterile water emulsion of pure culture in 1.5 ml Eppendorf tubes, which was double centrifuged (with 500 µL sterile distilled water at 14,000 × g for 5 min). The heated pellets in 200 µL of sterile distilled water, at 100 °C for 10 min (using a heater of Labnet, FL, USA) were heat-shocked (for 15 min), centrifuged (at 14,000×g for 5 min) and DNA was stored at –20 °C.

Genomic DNA extraction (Yunjie and Oluseyi, 2013) was also done using Bioneer DNA extraction kit (Accuprep). This involved centrifugation of *Listeria* cell pellets (at 8000 rpm for 5 min). Genomic binding (GB) Buffer (200 µl) was added to suspended pellets with Proteinase K (20 µl) and RNase (10 µl, 2 min, at room temperature) and then incubated (at 60 °C for 10 min). Supernatant with centrifuged lysate (400 µl of 100% ethanol, 1 min, 8000 rpm) was transferred into new binding column tubes, and centrifuged (in 500 µl of Wash Buffer 1 solution, at 8000 rpm for 1 min). In new clean collection tubes, suspension was filtered and centrifuged (in 500 µl of Wash Buffer 2 at 8000 rpm for 1 min) and ethanol was removed by centrifugation (12000 rpm for 1 min). Transferring of DNA into sterile eppendorf tubes (1.5 ml) was done with elution (200 µl of elution buffer) by centrifugation (1min at 8000 rpm). Thereafter, nanodrop lite (Thermo Fisher scientific spectrophotometer) was used to quantify the concentration of DNA, and stored properly at -20 °C.

Genome Identification and Sequencing

Polymerase Chain Reaction (PCR) amplification was used for detection of *Listeria spp* (Weisburg *et al.*, 1991 and Yunjie and Oluseyi, 2013), using 16S RNA of 1500bp amplicon size, primers (F: 5¹-AGAGTTTGATCCTGGCTCAG-3¹ and R: 5¹-AGGAGGTGATCCAGCCG CA-3¹) and 20 µl of pre-mix (Accupower). Conditions of PCR were as follows: Initial denaturation (95 °C for 5 min); Cycle (35); Denaturation (95 °C for 2 min); Initial elongation (42 °C for 30 s); Final extension (72 °C for 2min); Initial extension (72 °C for 4 min); Final elongation (72 °C for 10 min); and cooling (4 °C). Amplicons were virtualized in a UV trans-illuminator after it had been subjected to electrophoresis with TAE buffer (100 ml), DNA ladder (5 µl) and negative-positive control, at 80 volts for 45 min. Prior to sequencing of bands, purification was done using QIAquick Gel Extraction Kit and the QIAquick PCR and Gel Cleanup Kit.

DNA sequencing was executed at International Institute of Tropical Agriculture (IITA) Bioresource Center, Ibadan, Oyo State, Nigeria. The purified bands from 16S rRNA gene for the *Listeria spp* isolates were subjected to the Bigdye Terminator V3.1 cycle sequencing kit (Perkin-Elmer) in an Applied Biosystems 3130 Sequencer (ABI, USA). Purified sequence reaction with centrisep (spin column) was identified according to Blanco-Picazo *et al.* (2022), blasted and analyzed using Basic Local Alignment Search Tool (BLAST, <https://blast.ncbi.nlm.nih.gov/Blast.cgi>).

Virulence Genes and Antimicrobial Resistance Genes Assay

According to Areo *et al.* (2025) and Agboola and Bisi-Johnson (2023) respectively, Polymerase Chain Reaction (PCR) assays were used to detect 18 antimicrobial resistance genes: fluoroquinolone (*gyrA* and *gyrB* genes), carbapenem (*NDM*, *KPC*, and *IMP* genes), Extended-Spectrum beta-Lactamase Producing (ESBL) (*SHV*, *TEM* and *CTX* genes) activity, vancomycin (*vanA* and *vanB* genes), chloramphenicol (*catA* gene), aminoglycoside (*AadA* gene), tetracycline (*tetA* gene), folates (*dfrA14* gene) and macrolides (*mefA*, *msrA*, *ereA* and *ermX* genes); and 9 virulence-associated genes: *prs*, *hlyA*, *clpE*, *plcA*, *plcB*, *prf*, *iniB* and *RADP*. The conditions for

PCR for each primer were given in Supplementary Table S1 and Supplementary Table S2 respectively.

Statistical Analysis

Microsoft Excel spreadsheet and SPSS software package (SPSS 20.0 for Windows 7, SPSS Inc, Chicago, Illinois) were used on proportioned data. Relationship of genes prevalence data from various locations was established by multinomial regression analysis and Pearson chi-square (Statistical Analysis Software 92.2), at $P \leq 0.05$ significant difference.

RESULTS

Listeria spp from Specific Fresh Vegetables with Antimicrobial-Resistant Genes (ARG)

Twenty-five dataset observation on Table 1 indicate the presence of *Listeria spp* (32) with examined occurrence of antimicrobial resistance genes (ARG) from fluoroquinolone, carbapenem, vancomycin, chloramphenicol, aminoglycoside, tetracycline, folates, and macrolides groups. Nine *L. monocytogenes*, seven *L. ivanovii*, three *L. seegligeri*, four *L. welshimeri*, five *L. grayi*, two *L. innocua* and two other *Listeria spp* (*L. swaminathanii* and *L. cossartiae*) carried at least one of *gyrA*, *gyrB*, *NDM*, *KPC*, *IMP*, *SHV*, *TEM*, *CTX*, *vanA*, *vanB*, *catA*, *AadA*, *tetM*, *dfrA14*, *mefA*, *msrA*, *ereA* and *ermX* genes. However, *mefA*₁, *MsrA*₁, *ereA*₁ and *ermX*₁ with *mefA*₂, *MsrA*₂, *ereA*₂ and *ermX*₂ resistance genes represent macrolides genes for erythromycin and azithromycin respectively.

Lesser frequency of ARG 0 (0.00%) accounting for respective 72%, 96%, 96%, 80%, 64% and 96% were in *L. monocytogenes* from cabbage (from Agege market), carrot and cucumber; *L. ivanovii* from cabbage from Oyingbo market and *L. seegligeri* from cucumber from Oyingbo market (Table 1). Antimicrobial resistance gene (ARG) incidence in *L. welshimeri*, *L. grayi* and *L. innocua*, in order of Lagos, Osun and Ondo States were 5 (33.33%), 6 (40.00) and 4 (26.67); 2 (33.33%), 4 (66.67%) and 0 (0.00%) and 8 (100.00), 0 (0.00%) and 0 (0.00%). Higher prevalence of antimicrobial resistance genes (ARG) were found in *L. monocytogenes* from vegetables in Osun State while those in *L. ivanovii* and *L. seegligeri* were in vegetables from Lagos State. Evidence of this was observed from *L. monocytogenes*, *L. ivanovii* and *L. seegligeri*, having ARG incidence of 7 (22.58%), 20 (64.52%) and 4 (12.90%); 9 (52.25%), 4 (25.00%) and 3 (18.75%) as well as 2 (22.22%), 1 (11.11%) and 6 (66.67%) in respective Lagos, Osun and Ondo States. Highest frequency of ARG of value 5 (21.74%) was discovered in *L. monocytogenes* from Agege marketed cabbage.

Most of the *L. monocytogenes* were fluoroquinolone and macrolide resistant; *L. ivanovii* were vancomycin resistant; and *L. seegligeri* were macrolides and folate resistant. Although, *L. monocytogenes* carried chloramphenicol, aminoglycoside and vancomycin genes; *L. ivanovii* had carbapenem genes whereas *L. seegligeri* were chloramphenicol, aminoglycoside, tetracycline and vancomycin genes. The rare Extended-Spectrum beta-Lactamase Producing (ESBL) (*SHV*, *TEM* and *CTX* genes) was found in *L. ivanovii* from cucumber in Ile-Epo and Oyingbo markets; and *L. seegligeri* from Balogun market. Extended-Spectrum beta-Lactamase Producing (ESBL) (*SHV*, *TEM* and *CTX* genes) was likewise found in *L. welshimeri* from cabbage in Mile 12 and Oja-Oba Ikare markets with cucumber in Oja-Oba Owo market. Most *L. welshimeri* were chloramphenicol, vancomycin and macrolide resistant; *L. innocua* were macrolides, vancomycin and fluoroquinolone resistant; while *L. grayi* were macrolides, vancomycin, aminoglycoside and chloramphenicol resistant.

Listeria spp from Specific Fresh Vegetables with Virulence Genes (VRG)

Eighteen of nineteen pathogenic *Listeria* strains (Table 2) in fresh vegetables carried at least one virulence gene with distribution in eight *L. monocytogenes*, seven *L. ivanovii* and three *L. seegligeri*. Incidence rate of virulence genes were determined in *L. monocytogenes*, *L. ivanovii* and *L. seegligeri* from vegetables at Lagos (11 (22.92%), 32 (66.67%), and 5 (10.42%)), Osun (38 (64.41%), 15 (25.42%)) and 6 (10.17%) and Ondo States (6 (26.09%), 8 (34.78%) and 9 (39.13%)) respectively. Virulence genes were noted in *L. monocytogenes* from cabbage 9 (23.68%) at Oja-Titun Ife market; *L. ivanovii* from carrot 9 (28.88%) (at Sabo-Ikorodu market) and cucumber 9 (28.88%) (at Ile-Epo market); with *L. seegligeri* from cabbage 9 (100.00%) at Okitipupa market. Other virulent species lack at least one of *prs*, *hlyA*, *clpE*, *plcA*, *prfA*, *plcB*, *IniB*, *actA* and *RADP* genes. For instance, *Listeria monocytogenes* in cabbage from Agege market 7 (63.64%) and Oshodi market, 4 (36.36) had *prs*, *hlyA*, *clpE*, *plcA*, *prfA*. *IniB*, *actA*, *RADP* genes except *plcB* gene.

Out of thirteen of other *Listeria* strains, only *L. innocua* from cabbage at the Ile-Epo market had all *prs*, *hlyA*, *clpE*, *plcA*, *prfA*, *plcB*, *IniB*, *actA* and *RADP* genes. Two *L. innocua* (from cabbage at Sabo Iwo market carried *prs*, *prfA*, *plcB* and *IniB* genes. Four *L. welshimeri* in vegetables from Lagos, Osun, and Ondo States had apportioned *prs*, *plcA*, *prfA*, *plcB*, *IniB*, *actA* and *RADP* genes in cabbage 5 (100.00%), 4 (100.00%) and 3 (50.00%) in Mile-12, Sabo Iwo, Oja-Oba Ikare markets respectively; and in cucumber 3 (50.00%) from Oja-Oba Owo market. Five *L. grayii* from vegetables from Lagos (n=20), Osun (n=3) and Ondo States (n=0) had *prs*, *hlyA*, *clpE*, *plcA*, *prfA*, *plcB*, *IniB*, *actA* and *RADP* genes in cabbage from Lekki (7 (77.78%), Sabo Iwo (4 (28.57%) and Orisunbare 6 (42.86%) markets; with carrot from Mushin 2 (2.22%) and Oja-Ale Iwo (4 (28.57%) markets (Table 2). *L. welshimeri*, *L. innocua* and *L. grayii* from vegetables from Ondo Lagos, Osun and Ondo States had virulence genes frequency rate of 5 (21.74%), 9 (39.13%), and 9 (39.13%); 4 (9.52%), 34 (80.95%) and 4 (9.52%) as well as 6 (100.00%), 0 (0.00%) and 0 (0.00%) respectively.

DISCUSSIONS

Listeriosis infection are limited in Nigeria, but presence of resistant species in commonly eaten foods like vegetables could create deadly alert that needs regular intervention. Resistant *L. spp* are ubiquitous, so, there are a lot of routes in which antimicrobial resistance and virulence genes could be transferred to *L. spp* that attach themselves to vegetables. Incidence of *L. monocytogenes* in vegetables could be due to the level of exposure to harboring contaminants on the farms, markets, and during storage, transportation as well as processing. Olabiwoninu *et al.* (2023) discoveries also agreed that inappropriate practices on farm, in market and during handling must be checked, but dominant route is cross-contamination of surfaces or contact with vegetables. Patra *et al.* (2025) and Agboola and Bisi-John (2023) highlighted that multi-drug transferable anti-resistant genes could be sourced from sewage sludge-water, irrigating water, cultivating soil, and surfaces of perishables. Brun *et al.* (2022) and Areo *et al.* (2025) reported resistant *L. spp* isolates from agricultural soil, manure fertilizer, root crop, water, pulses and grains, culinary herbs, salad crops, ready-to-eat foods, and fruits. Oyedele *et al.* (2020) confirmed that vegetables are highly biodegradable. *Listeria spp* could cause a shortage, waste, and quality loss of vegetables to the extent that they may not allow efficient food security in nations and good nutrition to consumers (Oyedele *et al.*, 2020).

Extended-Spectrum beta-Lactamase Producing (ESBL) (*SHV*, *TEM* and *CTX* genes) detection in gram-positive *Listeria* strains could be as a result of acquiring of the genes during cross-contamination from farm to market. Though, this was in agreement to the work of Ibrahim *et al.*

(2023), who reported ESBL (TEM, SHV and CTX-M) genes with higher prevalence in gram-positive bacteria (*Staphylococcus spp*) compared to gram-negative bacteria. Oyeyipo *et al.* (2022) found ESBL genes in *Escherichia coli* from fruit and vegetable salads. Although, Kayode and Okoh (2022) discovered twenty tetracyclines, sulphonamides, phenicols, aminoglycosides, β -lactamases, and extended-spectrum of β -lactamases (ESBLs) coding resistance genes, but *tetM*, *sul2* and *sul1* were most prevalence, which agreed to the outcome of this research.

Favorable environmental conditions, virulence genes in *Listeria* strains, and carbon-nutrient supplied by vegetables stimulate the survival of *L. spp*. Virulence genes were detected from the work which may be acquired from active, inactive or weak strains. in accordance to Hasani *et al.* (2020), reports from this work also reflected acquiring of genes during cross-contamination in *Listeria spp* with food and non-food infected contact. Some of the non-pathogenic *Listeria* could carry pathogenicity factor or genes due to mutation. As seen in this study, Zakrzewski *et al.* (2020) also indicated the presence of *hlyA* gene in non-pathogenic *L. innocua*.

Some vegetables from this data-based result had ARG with the height of the critical stage in human nutrition and medicine. Many *L. spp* could exhibit higher proportion of ARG but the levels from this study are still controllable if surveillance arises on time. This means that if one-health actions from various sectors are employed, such AMR could be curbed on time. Reports of fresh marketed vegetables containing hypervirulent and multiple resistant *Listeria* strains, in this work, concur with the multidrug-resistant *Listeria* strains gotten by Oyeyipo *et al.* (2022). This agreed with Miyebi *et al.* (2018) on attributed factors of unhygienic handling during processing, packaging, and cross-contamination due to overcrowding in the market. However, data from this study affirmed that *L. monocytogenes* were found to be multidrug resistant.

This research also detected other *Listeria* strains which were in accordance to Areo *et al.* (2025) and Hasani *et al.* (2020). All strains are capable to grow, survive and be spread in the gut of consumers or transmitted to other foods in contact with them, via *IniB*, *prs*, *plcA* and *plcB* genes regulated by (*prfA* gene) in presence of *clp* and *actA* genes. They could thereby cause consumers to be susceptible to listeriosis and related outbreaks by *RADP* gene while producing *hlyA* genes. Obviously, attachment genes of *Listeria spp* (*prs*, *plcA*, *plcB*) were found, which are always active in the presence of *clp*, internalins (*int*), and actin (*act*) genes. Their effect of *RADP* gene is more significant in the gut with reoccurring listeriosis outbreak spread and prevalence in locations of sampling, if proper care is not taken. Regulating genes, *prf* gene were likewise found in *Listeria spp* detected from this study. This outcome reflected the survival rate of the strains in unfavourable conditions due to listeriolysin O (*hlyA*) genes detected.

CONCLUSIONS

Based on the research, the study concludes that there was presence of six strains of *Listeria spp* including *Listeria monocytogenes* in vegetables obtained in Nigerian markets. This is because of inadequate food safety and preservation methods employed from farm-market supply chain. Although, some *Listeria spp* were of zero prevalence of virulence and antimicrobial resistance genes, showing thorough washing of fresh vegetables with hygienic handling, even at market level (which has prevented *Listeria* contamination within specific sample location). From the finding, it can be concluded that many of the strains with incidence of virulence and resistance genes in vegetables at specific sample location were consequences of cross-contamination. Handlers must thereby ensure good production, hygienic handling and practices from farm to plate. Vegetables which are widely recommended to all populace in Nigeria, especially the vulnerable people, must be taken care of strictly in order to prevent *Listeria* contamination and listeriosis outbreak amidst consumers. Thus, hygienic safety of fresh vegetables and surveillance with enforcement of good prevention and handling strategies are recommended.

Ethical clearance

The researcher strictly adheres to all necessary research ethics at every levels of this study.

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Author and Contributors

Areo E.O. (Methodology, Conceptualization, Software, Validation, Formal Analysis, Investigation, Resources, Administration, Data Curation, Project Funding Acquisition, Writing – Original Draft Preparation, Visualization)

Conflict of Interest Disclosure

The author declares that there are no conflicts of interest.

Available data and materials

The datasets on which the conclusions were made were from the outcomes of the research work.

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SUPPLEMENTARY TABLE

Table S1: Antimicrobial resistance genes primer sequence and PCR conditions

Gene target	Antimicrobial	Antimicrobial Group	Sequence (5–3)	Amplification conditions	Amplicon size (bp)	References
<i>Aad6</i>	Gentamycin and Streptomycin	Aminoglycosides	GTGGATGGCGGCTGAAGCC AATGCCAGTCGGCAGCG	Denaturation: 3 min at 94°C; 30 cycles of 30 s Annealing temperature: 30 s at 58°C and Final elongation step at 72°C for 1 min; Final extension of 72 °C for 7 min; and final cooling at 4 °C	528	Soubeiga <i>et al.</i> (2022) https://doi.org/10.1155/2022/9640828
<i>tetM</i>	Tetracycline	Tetracycline	CCCCGAAGAACGTTTTC ATCAGCAATAAACACAGC	Annealing temperature of 51, Denaturation: 5 min at 95 °C, 30 cycles with 40 s at 95°C, 40 s at 50-64°C Final elongation 75 s at 72 °C and 8 min of Final extension at 72 °C and final cooling at 4 °C	517	Bisi-Johnson <i>et al.</i> (2023) https://doi.org/10.1038/s41598-023-38014-y
<i>gyrA</i>	Ciprofloxacin	Flouroquinolones	GCGCGTGAGATGACCCGCCGT CTGGCGGTAGAAGAAGGTCAG	Denaturation: 5 min at 94 °C prior to 35 cycles of 1 min at 94 °C, Annealing temperature at 54 °C for 1 min, Final elongation: 72 °C and 8 min; Extension at 72 °C for 1 min and final cooling at 4 °C	448	Abakpa <i>et al.</i> (2015) https://doi.org/10.1016/j.enmm.2014.11.004 .
<i>gyrB</i>			TCCGGCGGTCTGCACGGCGT CCTTGACCGAAATGACCGCC	Initial denaturation: 95 °C for 5 min, followed by 30 cycles at 94 °C for 1 min; (denaturation); 61 °C for 1 min (annealing); Final elongation: 72 °C and 7 min; 72 °C for 1 min (extension); and final cooling at 4 °C	1100	Soler <i>et al.</i> (2004) https://doi.org/10.1099/ij.s.0.03048-0 .
<i>NDM</i>	Ampicillin	Carbapenem	TAAAATACCTTGAGCGGGC AAATGGAAACTGGCGACC	Denaturation: at 95°C for 5 min, 35 cycles at 95 °C. annealing temperature at 52 °C; Final elongation: 72 °C and 8 min; Extension at 72 °C for 1 min; and final cooling at 4 °C	439	Mlynarcik <i>et al.</i> (2016) https://doi.org/10.5812/jjm.29314
<i>KPC</i>			TGTTGCTGAAGGAGTTGGGC ACGACGGCATAGTCATTTCG	Denaturation: at 95°C for 5 min, 35 cycles at 95 °C. annealing temperature at 56 °C; Final elongation: 72 °C and 8 min; Extension at 72 °C for 1 min; and final cooling at 4 °C	340	Mlynarcik <i>et al.</i> (2016) https://doi.org/10.5812/jjm.29314
<i>IMP</i>			AAAGGCACTGTTTCCTCACA TCGCCAGCCAATAACTAACC	Denaturation: at 95°C for 5 min, 35 cycles at 95 °C. annealing temperature at 60 °C; Final elongation: 72 °C and 8 min; Extension at 72 °C for 1 min; and final cooling at 4 °C	532	Mlynarcik <i>et al.</i> (2016) https://doi.org/10.5812/jjm.29314
<i>dfrA14</i>	Imipenem	Folate	TTAACCCAGGATGAGAACCT CGATTGCATAGCTTTGTAA		510	Miranda <i>et al.</i> (2016) https://doi.org/10.3389/fcimb.2016.00077
<i>mefA</i>	Trimethoprim-Sulphanamide	Macrolides	CAATATGGGCAGGGCAAGAAG CTGTTCCTCAATGCTACGC	Denaturation: at 95°C for 5 min, 30 cycles at 95 °C. annealing temperature at 60 °C Final elongation: 72 °C and 8 min; Extension at 72°C for 75 s; and final cooling at 4 °C	317	Dec <i>et al.</i> (2018) https://doi.org/10.1186/s12866-018-1269-6
<i>MsrA</i>			TCCAATCATTGCACAAAATC AATTCCCTCTATTGGTGGT	Denaturation: at 94 °C for 5 min, 35 cycles at 94 °C. annealing temperature at 55 °C Final elongation: 72 °C and 8 min; Extension at 72°C for 1 min; and final cooling at 4 °C	163	Wu <i>et al.</i> (2019) https://doi.org/10.3389/fmicb.2019.00304 .
<i>ereA</i>			GCCGGTGCTCATGAACCTTGAG CGACTCTATTTCGATCAGAGGC	Denaturation: at 95°C for 5 min, 30 cycles at 95 °C. annealing temperature at 57 °C; Final elongation: 72 °C and 7 min; Extension at 72°C for 1 mins and final cooling at 4 °C	419	Webale <i>et al.</i> (2020) http://dx.doi.org/10.4314/ejhs.v30i6.5
<i>ermX</i>			GTTCGCTCTAACCGCTAAGGC CATGGGGACCACTGAGCCGTC	Denaturation: at 95°C for 5 min, 30 cycles at 95 °C. annealing temperature at 60 °C; Final elongation: 72 °C and 8 min; Extension at 72°C for 75 ; and final cooling at 4 °C .	571/657	Bisi-Johnson <i>et al.</i> (2023) https://doi.org/10.1038/s41598-023-38014-y
<i>CTX</i>	Erythromycin and Azithromycin	Beta-Lactamase	CGATGTGCAGTACCAGTAA TTAGTGACCAGAATAAGCGG		585	Bisi-Johnson <i>et al.</i> (2023) https://doi.org/10.1038/s41598-023-38014-y
<i>SHV</i>			AGGATTGACTGCCTTTTGT ATTTGCTGATTTGCTCG		393	Bisi-Johnson <i>et al.</i> (2023) https://doi.org/10.1038/s41598-023-38014-y



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TEM			GCGGTATCATTGCAGCACTG	Denaturation: at 95°C for 5 min, 30 cycles at 95 °C. annealing temperature at 55 °C; Final	1000	Muriuki <i>et al.</i> (2020)
catA	Amoxillin-Clavulanic	Phenicol	TGCTTAATCAGTGAGGCACC	elongation: 72 °C and 145 s; Final extension step at 72 °C for 5 min; and final cooling at 4 °C		https://doi.org/10.1155/2020/6572693
			CCAGACCGTTCAGCTGGATA	Denaturation: at 94°C for 5 min, 30 cycles at 95 °C. annealing temperature at 55 °C	454	Jeamsripong (2023)
VanA	Vancomycin		CATCAGCACCTTGTCGCCT	Final elongation: 72 °C and 7 min; and final cooling at 4 °C		https://doi.org/10.1371/journal.pone.0283359
			TGGTCCCGGAACAACATTTAT	Denaturation: at 95°C for 5 min, 30 cycles at 95 °C. annealing temperature at 56 °C	268	Akya <i>et al.</i> (2020)
			TCCACCGACAATAGAATAGGG	Final elongation: 72 °C and 145 s; Final extension step at 72 °C for 5 min; and final cooling at 4 °C		
VanB			GCTGCGAATTCAGTTGTTACA	Denaturation: at 95°C for 5 min, 30 cycles at 95 °C. annealing temperature at 55 °C; Final	136	Akya <i>et al.</i> (2020)
			CTGACCAATCCCACCATTTTA	elongation: 72 °C and 145 s; Final extension step at 72 °C for 5 min; and final cooling at 4 °C		

Table S2: Virulence genes and PCR conditions

Targeted genes	Sequence (5–3)	Amplification conditions	Amplicon size (bp)	References
<i>prs</i>	GCTGAAGAGATTGCGAAAGAAG CAAAGAAACCTTGGATTTCGGG	Denaturation: 95 °C (5 min), Elongation: 46 °C (1 min), 30 cycles; Extension: 72 °C (1 min); Cooling at 4 °C	370	Agboola and Bisi-Johnson (2023) https://doi.org/10.1016/j.sciaf.2022.e01503
<i>hlyA</i>	GTTAATGAACCTACAAGCCTTCC AACCGTTCTCCACCATTCCCA		708	
<i>clp E</i>	CTCCTTTTAAAAATGAGAAATGAAAGGTCTTG TTAAAGTAATGCCAGGCGGTCTAGAACATTG		518	
<i>plcA</i>	AAGTTGAGTACGAAYTGCTCTACTTTGTTG AACACAAACGATGTCATTGTACCAACAAC TAG	Denaturation: 95 °C (30 min), Elongation: 56 °C (30 min), 30 cycles; Extension: 72 °C (1 min); Cooling at 4 °C	600	
<i>plcB</i>	GATAACCCGACAAATACTGACGTAAATAC TCATCTGAGCAAAATCTTTTGCTACCATGTGTC	Denaturation: 95 °C (5 min), Elongation: 50 °C (1 min), 30 cycles; Extension: 72 °C (1 min); Cooling at 4 °C	503	
<i>prf</i>	CTGTTG GAGCTCTTCTTGGTGAAGCAATCG AGC AAC CTC GGT ACC ATA TAC TAA CTC	Denaturation: 95 °C (5 min), Elongation: 57 °C (1 min), 30 cycles; Extension: 72 °C (1 min); Cooling at 4 °C	1060	
<i>IntB</i>	AATCACITTTCTTTGGAGCATAATGGTATAAGTG GTTCCATCAACATCATAACTTACTGTGTAAACC	Denaturation: 95 °C (5 min), Elongation: 50 °C (1 min), 32 cycles; Extension: 72 °C (1 min); Cooling at 4 °C	562 bp	
RAPD	OPAI 5'-CA AT CG CC GT-3'	Denaturation: 95 °C (5 min), Elongation: 50 °C (1 min), 30 cycles; Extension: 72 °C (1 min); Cooling at 4 °C		



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Table 1: *Listeria spp* contamination prevalence in fresh vegetables with antimicrobial resistant genes (ARG)

Antimicrobial Resistance Genes	<i>Listeria monocytogenes</i> , Cabbage (Agege)	<i>Listeria monocytogenes</i> , Cabbage (Oshodi)	<i>Listeria monocytogenes</i> , Cucumber (Okitipupa)	<i>Listeria monocytogenes</i> , Cabbage (Oja-Titun Ife)	<i>Listeria monocytogenes</i> , Carrot (Ota-Efun)	<i>Listeria monocytogenes</i> , Cucumber (Igbona)	<i>Listeria monocytogenes</i> , Cucumber (Odori)	<i>Listeria monocytogenes</i> , Cucumber (Ifon-Osun)	<i>Listeria monocytogenes</i> , Cabbage (Shasha)	Number of Cases	<i>Listeria ivanovii</i> , Cabbage (Oyingbo)	<i>Listeria ivanovii</i> , Carrot (Sabon-Ikorodu)	<i>Listeria ivanovii</i> , Cucumber (Ile-Epo)	<i>Listeria ivanovii</i> , Cucumber (Oyingbo)	<i>Listeria ivanovii</i> , Cabbage (Ota-Efun)	<i>Listeria ivanovii</i> , Carrot (Igbona)	<i>Listeria ivanovii</i> , Cabbage (Isinkana)	Number of Cases	<i>Listeria seegleri</i> , Cabbage (Okitipupa)	<i>Listeria seegleri</i> , Cucumber (Orisunbare)	<i>Listeria seegleri</i> , Cabbage (Balogun)	Number of Cases
SHV	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (25.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
TEM ₁	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (33.33)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
CTX	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (20.00)	1 (20.00)	1 (20.00)	0 (0.00)	0 (0.00)	0 (0.00)	3 (13.04)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
tetM	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (20.00)	1 (20.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (4.35)	1 (50.00)	0 (0.00)	0 (0.00)	1 (4.35)
gyrA	1 (16.67)	1 (16.67)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (16.67)	0 (0.00)	0 (0.00)	13.04	0 (0.00)	0 (0.00)	0 (0.00)	1 (16.67)	0 (0.00)	0 (0.00)	0 (0.00)	1 (4.35)	0 (0.00)	1 (16.67)	0 (0.00)	1 (4.35)
gyrB	1 (33.33)	1 (33.33)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	8.70	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
NDM	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (100.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
KPC	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (100.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
IMP	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
<i>mefA₁</i>	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (25.00)	0 (0.00)	1 (25.00)	0 (0.00)	8.70	0 (0.00)	1 (25.00)	1 (25.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	2 (8.70)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
<i>MsrA₁</i>	1 (25.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	4.35	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (25.00)	0 (0.00)	0 (0.00)	1 (4.35)
<i>ereA₁</i>	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (20.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (4.35)	1 (20.00)	1 (20.00)	0 (0.00)	2 (8.70)
<i>ermX₁</i>	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
<i>mefA₂</i>	0 (0.00)	0 (0.00)	0 (0.00)	1 (16.67)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (16.67)	8.70	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (16.67)	1 (16.67)	0 (0.00)	2 (8.70)
<i>MsrA₂</i>	1 (50.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	4.35	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
<i>ereA₂</i>	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (25.00)	0 (0.00)	0 (0.00)	4.35	1 (25.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
<i>ermX₂</i>	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
<i>dfra14</i>	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (100.00)	0 (0.00)	0 (0.00)	1 (4.35)
<i>Aad6</i>	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (33.33)	1 (33.33)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	2 (8.70)	1 (33.33)	0 (0.00)	0 (0.00)	1 (4.35)
<i>Aad6</i>	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (33.33)	0 (0.00)	0 (0.00)	0 (0.00)	4.35	1 (33.33)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
<i>catA</i>	1 (16.67)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	4.35	0 (0.00)	0 (0.00)	1 (16.67)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
<i>vanA</i>	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (33.33)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
<i>vanB</i>	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (7.14)	1 (7.14)	0 (0.00)	1 (7.14)	1 (7.14)	4 (17.39)	1 (7.14)	0 (0.00)	1 (7.14)	1 (7.14)	1 (7.14)	1 (7.14)	1 (7.14)	6 (26.09)	1 (7.14)	0 (0.00)	0 (0.00)	1 (4.35)
Number of ARG Cases per isolate	5	2	0	1	1	3	2	2	2		3	3	7	7	2	3	2		7	6	0	
No prevalence	21.74	8.70	-	4.35	4.35	13.04	8.70	8.70	8.70		13.04	13.04	30.43	30.43	8.70	13.04	8.70		30.43	26.09	-	
Number of ARG Cases per isolate	78.26	91.30	100.00	95.65	95.65	86.96	91.30	91.30	91.30		86.96	86.96	69.57	69.57	91.30	86.96	91.30		69.57	73.91	100.00	
	3 (13.04)	2 (8.70)	0 (0.00)	1 (4.35)	1 (4.35)	3 (13.04)	2 (8.70)	2 (8.70)	2 (8.70)		3 (13.04)	3 (13.04)	7 (30.43)	7 (30.43)	2 (8.70)	3 (13.04)	2 (8.70)		7 (30.43)	6 (26.09)	0 (0.00)	



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Table 1 contd: *Listeria spp* contamination prevalence in fresh vegetables with antimicrobial resistant genes (ARG)

Antimicrobial Resistance Genes	<i>Listeria welshimeri</i> , Carrot (Oja-Oba Owo)	<i>Listeria welshimeri</i> , Cucumber (Oja-Oba Owo)	<i>Listeria welshimeri</i> , Cabbage (Sabo Iwo)	<i>Listeria welshimeri</i> , Carrot (Mile 12)	Number of Cases	<i>Listeria grayi</i> , Cabbage (Sabo-Iwo)	<i>Listeria grayi</i> , Cabbage (Iloro)	<i>Listeria grayi</i> , Cabbage (Lekki)	<i>Listeria grayi</i> , Carrot (Ile-Epo)	<i>Listeria grayi</i> , Carrot (Shasha)	Number of Cases	<i>Listeria innocua</i> , Cabbage (Ile-Epo)	<i>Listeria innocua</i> , Cabbage (Sabo Iwo)	Number of Cases	Other <i>Listeria spp</i> (<i>L. swaminathanii</i>), Cucumber (Odori)	Other <i>Listeria spp</i> (<i>L. cossartiae</i>), Carrot (Sabo-Iwo)	Number of Cases
SHV	0 (0.00)	1 (25.00)	0 (0.00)	1 (25.00)	2 (8.70)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (25.00)	0 (0.00)	1 (4.35)
TEM ₁	0 (0.00)	1 (33.33)	0 (0.00)	1 (33.33)	2 (8.70)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
CTX	0 (0.00)	0 (0.00)	0 (0.00)	1 (20.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (20.00)	0 (0.00)	1 (4.35)
tetM	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
gyrA	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (16.67)	0 (0.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
gyrB	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (25.00)	0 (0.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
NDM	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
KPC	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
IMP	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
<i>mefA₁</i>	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
<i>MsrA₁</i>	0 (0.00)	1 (25.00)	0 (0.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	1 (25.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
<i>ereA₁</i>	0 (0.00)	1 (20.00)	0 (0.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (20.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)
<i>ermX₁</i>	0 (0.00)	1 (33.33)	0 (0.00)	0 (0.00)	1 (4.35)	0 (0.00)	1 (33.33)	0 (0.00)	0 (0.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	1 (33.33)	0 (0.00)	1 (4.35)
<i>mefA₂</i>	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (16.67)	0 (0.00)	0 (0.00)	0 (0.00)	1 (4.35)	1 (16.67)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)
<i>MsrA₂</i>	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (50.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
<i>ereA₂</i>	0 (0.00)	1 (25.00)	0 (0.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	1 (25.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
<i>ermX₂</i>	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (100.00)	0 (0.00)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
<i>dfpA14</i>	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Aad6	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Aad6	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (33.33)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)
<i>catA</i>	0 (0.00)	1 (16.67)	1 (16.67)	1 (16.67)	3 (13.04)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (16.67)	0 (0.00)	1 (4.35)
<i>vanA</i>	0 (0.00)	1 (33.33)	1 (33.33)	0 (0.00)	2 (8.70)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
<i>vanB</i>	0 (0.00)	0 (0.00)	0 (0.00)	1 (7.14)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	1 (7.14)	0 (0.00)	1 (4.35)	1 (7.14)	0 (0.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)
Number of ARG Cases per isolate	0	8	2	6		0	1	2	3	1		4	0		3	0	
No prevalence	-	34.78	8.70	26.09		-	4.35	8.70	13.04	4.35		17.39	-		13.04	-	
		65.22	91.30	73.91			95.65	91.30	86.96	95.65		82.61	100.00		86.96	100.00	
Number of ARG Cases per isolate	0 (0.00)	8 (34.78)	2 (8.70)	6 (26.09)		0 (0.00)	1 (4.35)	2 (8.70)	3 (13.04)	1 (4.35)		4 (17.39)	0 (0.00)		3 (13.04)	0 (0.00)	



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Table 1 contd: *Listeria spp* contamination cases in fresh vegetables with antimicrobial resistant genes (ARG)

Most Frequency ARG (frequency, Percentage)	0 (0.00)	1 (100.00)	1 (50.00)	1 (33.33)	1 (25.00)	1 (20.00)	1 (16.67)	1 (7.14)	Total Number of Cases	Most Frequency ARG (frequency, Percentage)	0 (0.00)	1 (100.00)	1 (50.00)	1 (33.33)	1 (25.00)	1 (20.00)
<i>Listeria monocytogenes</i> , Cabbage (Agege)	18	0	1	1	1	0	2	0	18	<i>Listeria welshimeri</i> , Carrot (Oja-Oba Owo)	23	0	0	0	0	0
<i>Listeria monocytogenes</i> , Cabbage (Oshodi)	21	0	0	1	0	0	1	0	21	<i>Listeria welshimeri</i> , Cucumber (Oja-Oba Owo)	15	0	0	3	2	1
<i>Listeria monocytogenes</i> , Cucumber (Okitipupa)	23	0	0	0	0	0	0	0	23	<i>Listeria welshimeri</i> , Cabbage (Sabo Iwo)	21	0	0	1	0	0
<i>Listeria monocytogenes</i> , Cabbage (Oja-Titun Ife)	22	0	0	0	0	0	1	0	22	<i>Listeria welshimeri</i> , Carrot (Mile 12)	17	0	0	2	1	1
<i>Listeria monocytogenes</i> , Carrot (Ota-Efun)	22	0	0	0	0	0	0	1	22	Number of Cases	4 (21.05)	0 (0.00)	0 (0.00)	6 (31.58)	3 (15.79)	2 (10.53)
<i>Listeria monocytogenes</i> , Cucumber (Igbona)	20	0	0	1	1	0	0	1	20	<i>Listeria grayi</i> , Cabbage (Sabo-Iwo)	23	0	0	0	0	0
<i>Listeria monocytogenes</i> , Cucumber (Odori)	21	0	0	0	1	0	1	0	21	<i>Listeria grayi</i> , Cabbage (Iloro)	22	0	0	1	0	0
<i>Listeria monocytogenes</i> , Cucumber (Ifon-Osun)	21	0	0	0	1	0	0	1	21	<i>Listeria grayi</i> , Cabbage (Lekki)	21	1	0	0	1	0
<i>Listeria monocytogenes</i> , Cabbage (Shasha)	21	0	0	0	0	0	1	1	21	<i>Listeria grayi</i> , Carrot (Ile-Epo)	20	0	1	0	1	0
Number of Cases	9 (32.14)	0 (0.00)	1 (3.57)	3 (10.71)	4 (14.29)	0 (0.00)	7 (25.00)	4 (14.29)	27 (100.00)	<i>Listeria grayi</i> , Carrot (Shasha)	22	0	0	0	0	0
<i>Listeria ivanovii</i> , Cabbage (Oyingbo)	20	0	0	1	1	0	0	1	20	Number of Cases	5 (35.71)	1 (7.14)	1 (7.14)	1 (7.14)	2 (14.29)	0 (0.00)
<i>Listeria ivanovii</i> , Carrot (Sabo-Ikorodu)	20	0	0	1	1	1	0	0	20	<i>Listeria innocua</i> , Cabbage (Ile-Epo)	19	0	0	1	0	1
<i>Listeria ivanovii</i> , Cucumber (Ile-Epo)	16	0	0	2	2	1	1	1	16	<i>Listeria innocua</i> , Cabbage (Sabo Iwo)	23	0	0	0	0	0
<i>Listeria ivanovii</i> , Cucumber (Oyingbo)	16	0	1	1	1	2	1	1	16	Number of Cases	2 (33.33)	0 (0.00)	0 (0.00)	1 (16.67)	0 (0.00)	1 (16.67)
<i>Listeria ivanovii</i> , Cabbage (Ota-Efun)	21	0	1	0	0	0	0	1	21	Other <i>Listeria spp</i> (<i>L. swaminathanii</i>), Cucumber (Odori)	20	0	0	1	0	1
<i>Listeria ivanovii</i> , Carrot (Igbona)	20	2	0	0	0	0	0	1	20	Other <i>Listeria spp</i> (<i>L. cossartiae</i>), Carrot (Sabo-Iwo)	23	0	0	0	0	0
<i>Listeria ivanovii</i> , Cabbage (Isinkan)	21	1	0	0	0	0	0	1	21	Number of Cases	2 (40.00)	0 (0.00)	0 (0.00)	1 (20.00)	0 (0.00)	1 (20.00)
Number of Cases	7 (20.59)	3 (8.82)	2 (5.88)	5 (14.71)	5 (14.71)	4 (11.76)	2 (5.88)	6 (17.65)	34 (100.00)							
<i>Listeria seegligeri</i> , Cabbage (Okitipupa)	16	1	1	1	1	1	1	1	16							
<i>Listeria seegligeri</i> , Cucumber (Orisunbare)	17	3	0	0	0	2	1	0	17							
<i>Listeria seegligeri</i> , Cabbage (Balogun)	23	0	0	0	0	0	0	0	23							
Number of Cases	3 (18.75)	4 (25.00)	1 (6.25)	1 (6.25)	1 (6.25)	3 (18.75)	2 (12.50)	1 (6.25)	16 (100.00)							



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Table 2: *Listeria spp* contamination cases and prevalence in fresh vegetables with virulence genes (VRG)

Virulence Genes	Prs	hlyA	clpE	plcA	plcB	prf A	InlB	actA	RAPD	Number of VRG Cases per isolate	No prevalence	p=0.05	Most Frequency ARG (frequency, Percentage)				Total Number of Cases
<i>Listeria spp</i> , Vegetable (market)													0 (0.00)	1 (5.00)	1 (4.76)	1 (4.35)	
<i>Listeria monocytogenes</i> , Cabbage (Agege)	1 (5.00)	1 (4.76)	1 (5.00)	1 (5.00)	0 (0.00)	0 (0.00)	1 (4.76)	1 (4.35)	1 (5.00)	7 (77.78)	2 (22.22)	2.09	2	4	2	1	9
<i>Listeria monocytogenes</i> , Cabbage (Oshodi)	0 (0.00)	0 (0.00)	0 (0.00)	1 (5.00)	0 (0.00)	1 (5.00)	1 (4.76)	1 (4.35)	0 (0.00)	4 (44.44)	5 (55.56)	2.35	5	2	1	1	9
<i>Listeria monocytogenes</i> , Cucumber (Okitipupa)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	9 (100.00)	-	9	0	0	0	9
<i>Listeria monocytogenes</i> , Cabbage (Oja-Titun Ife)	1 (5.00)	1 (4.76)	1 (5.00)	1 (5.00)	1 (4.35)	1 (5.00)	1 (4.76)	1 (4.35)	1 (5.00)	9 (100.00)	0 (0.00)	3.84	0	5	2	2	9
<i>Listeria monocytogenes</i> , Carrot (Ota-Efun)	1 (5.00)	1 (4.76)	1 (5.00)	0 (0.00)	0 (0.00)	1 (5.00)	1 (4.76)	1 (4.35)	1 (5.00)	7 (77.78)	2 (22.22)	11.23	2	4	2	1	9
<i>Listeria monocytogenes</i> , Cucumber (Igbona)	1 (5.00)	1 (4.76)	1 (5.00)	0 (0.00)	0 (0.00)	1 (5.00)	1 (4.76)	1 (4.35)	1 (5.00)	7 (77.78)	2 (22.22)	5.94	2	4	2	1	9
<i>Listeria monocytogenes</i> , Cucumber (Odori)	1 (5.00)	1 (4.76)	0 (0.00)	1 (5.00)	1 (4.35)	1 (5.00)	1 (4.76)	1 (4.35)	0 (0.00)	7 (77.78)	2 (22.22)	5.28	2	3	2	2	9
<i>Listeria monocytogenes</i> , Cucumber (Ifon-Osun)	1 (5.00)	1 (4.76)	1 (5.00)	0 (0.00)	0 (0.00)	1 (5.00)	0 (0.00)	1 (4.35)	1 (5.00)	6 (66.67)	3 (33.33)	2.05	3	4	1	1	9
<i>Listeria monocytogenes</i> , Cabbage (Shasha)	1 (5.00)	1 (4.76)	1 (5.00)	1 (5.00)	1 (4.35)	0 (0.00)	1 (4.76)	1 (4.35)	1 (5.00)	8 (88.89)	1 (11.11)	2.44	1	4	2	2	9
Number of Cases	7 (77.78)	7 (77.78)	6 (66.67)	6 (66.67)	3 (33.33)	6 (66.67)	7 (77.78)	8 (88.89)	6 (66.67)				8 (25.00)	8 (25.00)	8 (25.00)	8 (25.00)	32 (100.00)
<i>Listeria ivanovii</i> , Cabbage (Oyingbo)	1 (5.00)	1 (4.76)	1 (5.00)	1 (5.00)	1 (4.35)	1 (5.00)	0 (0.00)	0 (0.00)	1 (5.00)	7 (77.78)	2 (22.22)	27.46	2	5	1	1	9
<i>Listeria ivanovii</i> , Carrot (Sabon-Ikorodu)	1 (5.00)	1 (4.76)	1 (5.00)	1 (5.00)	1 (4.35)	1 (5.00)	1 (4.76)	1 (4.35)	1 (5.00)	9 (100.00)	0 (0.00)	20.64	0	5	2	2	9
<i>Listeria ivanovii</i> , Cucumber (Ile-Epo)	1 (5.00)	1 (4.76)	1 (5.00)	1 (5.00)	1 (4.35)	1 (5.00)	1 (4.76)	1 (4.35)	1 (5.00)	9 (28.88)	2 (22.22)	28.09	0	5	2	2	9
<i>Listeria ivanovii</i> , Cucumber (Oyingbo)	1 (5.00)	1 (4.76)	1 (5.00)	1 (5.00)	1 (4.35)	1 (5.00)	0 (0.00)	0 (0.00)	1 (5.00)	7 (77.78)	2 (22.22)	23.77	2	5	1	1	9
<i>Listeria ivanovii</i> , Cabbage (Ota-Efun)	1 (5.00)	1 (4.76)	1 (5.00)	1 (5.00)	1 (4.35)	0 (0.00)	1 (4.76)	1 (4.35)	1 (5.00)	6 (66.67)	1 (11.11)	18.05	1	4	2	1	9
<i>Listeria ivanovii</i> , Carrot (Igbona)	1 (5.00)	1 (4.76)	1 (5.00)	0 (0.00)	0 (0.00)	1 (5.00)	1 (4.76)	1 (4.35)	1 (5.00)	7 (77.78)	2 (22.22)	11.11	2	4	2	1	9



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<i>Listeria ivanovii</i> , Cabbage (Isinkan)	0 (0.00)	1 (4.76)	1 (5.00)	1 (5.00)	1 (4.35)	1 (5.00)	1 (4.76)	1 (4.35)	1 (5.00)	8 (88.89)	1 (11.11)	45.45	1	4	2	2	9
Number of Cases	6 (66.67)	7 (77.78)	7 (77.78)	6 (66.67)	6 (66.67)	6 (66.67)	5 (55.55)	5 (55.55)	7 (77.78)				5 (19.23)	7 (26.92)	7 (26.92)	7 (26.92)	26 (100.00)

Table 2 contd : *Listeria spp* contamination cases and prevalence in fresh vegetables with virulence genes (VRG)

Virulence Genes	Prs	hlyA	clpE	plcA	plcB	prf A	InlB	actA	RAPD	Number of VRG Cases per isolate	No prevalence	p=0.05	Most Frequency ARG (frequency, Percentage)				Total Number of Cases
													0 (0.00)	1 (5.00)	1 (4.76)	1 (4.35)	
<i>Listeria spp</i>, Vegetable (market)																	
<i>Listeria seegligeri</i> , Cucumber (Orisunbare)	1 (5.00)	1 (4.76)	1 (5.00)	1 (5.00)	1 (4.35)	0 (0.00)	0 (0.00)	1 (4.35)	0 (0.00)	6 (66.67)	3 (33.33)	9.38	3	3	1	2	9
<i>Listeria seegligeri</i> , Cabbage (Okitipupa)	1 (5.00)	1 (4.76)	1 (5.00)	1 (5.00)	1 (4.35)	1 (5.00)	1 (4.76)	1 (4.35)	1 (5.00)	9 (100.00)	0 (0.00)	9.49	0	5	2	2	9
<i>Listeria seegligeri</i> , Cabbage (Balogun)	0 (0.00)	0 (0.00)	0 (0.00)	1 (5.00)	1 (4.35)	1 (5.00)	0 (0.00)	1 (4.35)	1 (5.00)	5 (55.55)	4 (44.44)	37.77	4	3	0	2	9
Number of Cases	2 (22.22)	2 (22.22)	2 (22.22)	2 (22.22)	3 (33.33)	2 (22.22)	1 (11.11)	3 (33.33)	2 (22.22)				3 (27.27)	3 (27.27)	2 (18.18)	3 (27.27)	11 (100.00)
Other <i>Listeria spp</i> , (L. swaminathanii), Cucumber (Odori)	0 (0.00)	1 (4.76)	1 (5.00)	1 (5.00)	0 (0.00)	0 (0.00)	1 (4.76)	0 (0.00)	0 (0.00)	4 (44.44)	5 (55.56)	0 (0.00)	5	2	2	0	9
Other <i>Listeria spp</i> (L. cossartiae), Carrot (Sabo-Iwo)	0 (0.00)	1 (4.76)	1 (5.00)	1 (5.00)	1 (4.35)	0 (0.00)	0 (0.00)	0 (0.00)	1 (5.00)	5 (55.55)	4 (44.44)	0 (0.00)	4	3	1	1	9
Number of Cases	0 (0.00)	2 (22.22)	2 (22.22)	2 (22.22)	1 (11.11)	0 (0.00)	1 (11.11)	0 (0.00)	1 (11.11)				2 (25.00)	2 (25.00)	2 (25.00)	2 (25.00)	8 (100.00)
<i>Listeria welshimeri</i> , Carrot (Oja-Oba Owo)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)							
<i>Listeria welshimeri</i> , Cucumber (Oja-Oba Owo)	1 (5.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (4.76)	1 (4.35)	0 (0.00)	3 (33.33)	6 (66.67)	1.37	6	1	1	1	9
<i>Listeria welshimeri</i> , Cabbage (Sabo Iwo)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (4.35)	1 (5.00)	1 (4.76)	0 (0.00)	0 (0.00)	4 (44.44)	5 (55.56)	1.17	5	1	1	1	9
<i>Listeria welshimeri</i> , Carrot (Mile 12)	0 (0.00)	0 (0.00)	0 (0.00)	1 (5.00)	1 (4.35)	0 (0.00)	1 (4.76)	1 (4.35)	1 (5.00)	5 (55.55)	4 (44.44)	6.2	4	2	1	2	9
Number of Cases	1 (11.11)	0 (0.00)	0 (0.00)	1 (11.11)	2 (22.22)	1 (11.11)	3 (33.33)	2 (22.22)	1 (11.11)				3 (25.00)	3 (25.00)	3 (25.00)	3 (25.00)	12 (100.00)
<i>Listeria grayi</i> , Cabbage (Sabo-Iwo)	1 (5.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (4.35)	1 (5.00)	1 (4.76)	0 (0.00)	0 (0.00)	4 (44.44)	5 (55.56)	2.23	5	2	1	1	9
<i>Listeria grayi</i> , Cabbage (Iloro)	1 (5.00)	1 (4.76)	1 (5.00)	1 (5.00)	1 (4.35)	0 (0.00)	0 (0.00)	1 (4.35)	0 (0.00)	6 (66.67)	3 (33.33)	5.41	3	3	1	2	9
<i>Listeria grayi</i> , Cabbage (Lekki)	0 (0.00)	1 (4.76)	1 (5.00)	1 (5.00)	1 (4.35)	1 (5.00)	1 (4.76)	1 (4.35)	0 (0.00)	7 (77.78)	2 (22.22)	0.04	2	3	2	2	9
<i>Listeria grayi</i> , Carrot (Ile-Epo)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (4.35)	1 (5.00)	2 (22.22)	7 (77.78)	1.74	7	1	0	1	9
<i>Listeria grayi</i> , Carrot (Shasha)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (4.35)	1 (5.00)	0 (0.00)	1 (4.35)	1 (5.00)	4 (44.44)	5 (55.56)	0.22	5	2	0	2	9
Number of Cases	2 (22.22)	2 (22.22)	2 (22.22)	2 (22.22)	4 (44.44)	3 (33.33)	2 (22.22)	4 (44.44)	2 (22.22)				5 (27.278)	5 (27.278)	3 (16.67)	5 (27.278)	18 (100.00)
<i>Listeria innocua</i> , Cabbage (Ile-Epo)	1 (5.00)	1 (4.76)	1 (5.00)	1 (5.00)	1 (4.35)	1 (5.00)	1 (4.76)	1 (4.35)	1 (5.00)	9 (100.00)	0 (0.00)	4.9	0	5	2	2	9
<i>Listeria innocua</i> , Cabbage (Sabo Iwo)	1 (5.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (4.35)	1 (5.00)	1 (4.76)	0 (0.00)	0 (0.00)	4 (44.44)	5 (55.56)	7.87	5	2	1	1	9
Number of Cases	2 (22.22)	1 (11.11)	1 (11.11)	1 (11.11)	2 (22.22)	2 (22.22)	2 (22.22)	1 (11.11)	1 (11.11)				2 (25.00)	2 (25.00)	2 (25.00)	2 (25.00)	8 (100.00)