Journal of Plant Biota

Original Research Article
ISSN: 3048-4863
Journal homepage: https://plant.researchfloor.org/

Antibiotic Resistance Profile of Campylobacter jejuni from Edible Plant Biota in Kpiri-Kpiri Market, Abakaliki Metropolis, Nigeria

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Abstract

Background: *Edible plant biota, particularly raw fruits and vegetables, are essential for nutrition but serve as potential vehicles for foodborne pathogens. Campylobacter jejuni is a leading cause of human bacterial gastroenteritis worldwide, yet data on its contamination levels and antimicrobial resistance (AMR) profile in plant-based food from Nigerian markets remain limited. This study aimed to determine the prevalence and characterize the antimicrobial resistance profile of Campylobacter jejuni isolated from raw fruits and vegetables sold in Kpiri-Kpiri Market, Abakaliki Metropolis, Nigeria.*

Methods: *A total of 60 samples comprising 40 vegetables and 20 fruits were collected from Kpiri-Kpiri Market. Bacterial enumeration was performed using standard pour plate methods. Campylobacter species were isolated using selective media and identified via standard morphological and biochemical techniques, including the hippurate hydrolysis test for presumptive identification of C. jejuni. Antimicrobial susceptibility testing against ten antibiotics was conducted using the Kirby-Bauer disc diffusion method, and the Multiple Antibiotic Resistance (MAR) index was calculated.*

Results: *High contamination levels were observed across all samples, with bacterial loads ranging from 6.90×10^4 to 1.94×10^5 CFU/mL. Of the 60 samples analyzed, Campylobacter species were isolated from 32 samples (53.3%). Among these, Campylobacter jejuni was presumptively identified in 8 isolates (25.0% of Campylobacter-positive samples), representing 13.3% of the total samples analyzed. The 8 C. jejuni isolates were obtained from pumpkin leaf (3), cabbage (1), African pear (1), fresh tomato (1), cucumber (1), and watermelon (1). Antimicrobial susceptibility testing revealed that C. jejuni isolates from vegetables (n=7) exhibited 100% resistance to Ceftazidime, Cefotaxime, Cefoxitin, Meropenem, and Tetracycline, while maintaining 100% susceptibility to Ciprofloxacin and Gentamicin. Similarly, C. jejuni isolates from fruits (n=1) demonstrated 100% resistance to Ceftazidime, Cefotaxime, Cefoxitin, and Tetracycline, with 100% susceptibility to Ciprofloxacin and Gentamicin. The MAR values recorded for vegetable and fruit isolates stood at 0.61 and 0.50, respectively, both markedly above the 0.2 threshold considered indicative of high risk.*

Conclusion: *This study demonstrates that edible plant biota sold in Kpiri-Kpiri Market, Abakaliki Metropolis, are significantly contaminated with multidrug-resistant Campylobacter jejuni. The presence of such strains on fresh produce intended for raw consumption represents a serious public health risk requiring urgent intervention.*

Keywords: *Campylobacter jejuni, Antimicrobial Resistance, Edible Plant Biota, Kpiri-Kpiri Market, Fruits, Vegetables, Nigeria.*

1. INTRODUCTION

Edible plant biota, encompassing fruits and vegetables, are cornerstone components of a healthy human diet, providing essential nutrients, vitamins, minerals, and dietary fiber [1]. The global shift towards health-conscious eating has increased the demand for minimally processed and ready-to-eat plant-based foods [2,3]. However, this trend has concurrently elevated the risk of foodborne illnesses, as these foods are often consumed raw, bypassing a critical pathogen reduction step (cooking). Among the myriad of potential contaminants, *Campylobacter jejuni* has emerged as the leading bacterial cause of human gastroenteritis worldwide [4].

Campylobacter jejuni is a Gram-negative, spiral-shaped, microaerophilic bacterium. Clinical manifestations of *C. jejuni* infection range from self-limiting acute enteritis (diarrhea, abdominal pain, fever) to severe post-infectious sequelae, including Guillain-Barré syndrome, an autoimmune neurological disorder, and reactive arthritis [5]. Globally, *Campylobacter* species (predominantly *C. jejuni*) are estimated to cause over 95 million foodborne illnesses and 21,000 deaths annually, with a disproportionately high burden in low- and middle-income countries, including those in Africa [4].

The contamination of edible plant biota with *C. jejuni* can occur at multiple points along the farm-to-fork continuum, including

04 February 2026: Received | 03 March 2026: Revised | 08 April 2026: Accepted | 12 May 2026: Available Online

Citation: Ifeoma P. Ogbonna, Jerry O. Orji, Ikemesit U Peter, Bright N Abba, and Kelechi N Ogboji (2026). Antibiotic Resistance Profile of Campylobacter jejuni from Edible Plant Biota in Kpiri-Kpiri Market, Abakaliki Metropolis, Nigeria. *Journal of Plant Biota.* **73 to 78. DOI: https://doi.org/10.51470/JPB.2026.5.1.73**

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primary production (via contaminated irrigation water, soil, or untreated animal manure used as fertilizer), post-harvest handling, transportation, storage, and final preparation [6]. The use of untreated poultry litter and animal feces as organic fertilizer is a particularly significant pathway, as it directly introduces enteric pathogens like *C. jejuni* into the agricultural environment [7,8]. Open-air markets like Kpiri-Kpiri Market in Abakaliki Metropolis present additional contamination risks due to exposure to dust, flies, poor handling practices, and inadequate storage facilities [9].

Compounding the public health challenge is the escalating threat of antimicrobial resistance (AMR). The overuse and misuse of antibiotics in human and, critically, in animal agriculture have selected for resistant bacterial strains [10]. Food-producing animals, especially poultry, are major reservoirs of *C. jejuni*, and the use of antibiotics (e.g., tetracyclines, fluoroquinolones) for growth promotion or therapy in these animals drives resistance [8, 11]. Subsequently, resistant *C. jejuni* can be transmitted to humans through the consumption or handling of contaminated plant-based foods [12].

Despite the global significance, there is a paucity of comprehensive data on the burden and AMR profile of *C. jejuni* specifically isolated from edible plant biota in specific markets within Abakaliki Metropolis, Nigeria. Therefore, this study was designed to isolate and presumptively identify *Campylobacter jejuni* from raw fruits and vegetables sold in Kpiri-Kpiri Market, Abakaliki Metropolis, determine its prevalence, and characterize its antimicrobial susceptibility profile.

2. MATERIALS AND METHODS

2.1. Study Area and Description

This research was carried out at Kpiri-Kpiri Market, situated within the Abakaliki Metropolis in Ebonyi State, Southeastern Nigeria. Abakaliki, which serves as the state capital, lies at coordinates 6.32°N and 8.12°E [13]. As one of the largest traditional open-air markets in the area, Kpiri-Kpiri Market features a daily assortment of fresh produce including various fruits and vegetables sold under prevailing ambient conditions.

2.2. Sample Collection

A total of 60 samples comprising 40 vegetables and 20 fruits were aseptically purchased from Kpiri-Kpiri Market. The vegetable samples included cucumber, African pear, garden egg fruit, fresh tomato, fresh pepper, okro, carrot, garden egg leaf, pumpkin leaf, and cabbage (4 samples each). The fruit samples included tigernut, banana, watermelon, guava, and palm fruit (4 samples each). Each sample was collected into sterile sample bags, placed in a cooler box with ice packs (4-6°C), and transported to the laboratory for analysis within one hour of collection.

2.3. Bacterial Enumeration and Isolation

For each sample, 25g was aseptically rinsed in 225mL of sterile water. Serial ten-fold dilutions were prepared, and 0.1mL from appropriate dilutions was plated onto *Campylobacter* Blood-Free Selective Agar (Thermo Fisher Scientific, USA). Plates were incubated microaerophilically (using GasPak EZ Campy Container Systems, BD) at 42°C for 48 hours. Colonies exhibiting typical *Campylobacter* morphology (creamy-yellow, moist, irregular) were subcultured for purity. Total viable bacterial counts were expressed as Colony Forming Units per mL (CFU/mL) [14].

2.4. Phenotypic Identification of *Campylobacter jejuni*

Standard microbiological techniques were employed for the presumptive identification of *Campylobacter* isolates. Morphological characterization was first carried out via Gram staining to confirm the presence of Gram-negative, spiral, or curved rod-shaped cells. Motility was assessed using the hanging drop method, observing for characteristic darting motility. The oxidase test was performed using 1% tetramethyl-p-phenylenediamine dihydrochloride. For presumptive identification of *C. jejuni*, the hippurate hydrolysis test was conducted. Isolates that hydrolyzed sodium hippurate (positive test) were presumptively identified as *Campylobacter jejuni*.

2.5. Antimicrobial Susceptibility Testing

Antibiotic susceptibility was determined for all presumptive *C. jejuni* isolates (n=8) using the Kirby-Bauer disc diffusion method on Mueller-Hinton agar supplemented with 5% defibrinated sheep blood, following CLSI guidelines [15]. The following ten antibiotic discs (Oxoid, UK) were tested: Ceftazidime (30 µg), Cefotaxime (30 µg), Cefoxitin (30 µg), Imipenem (10 µg), Meropenem (10 µg), Ciprofloxacin (5 µg), Gentamicin (15 µg), Nitrofurantoin (25 µg), Erythromycin (15 µg), and Tetracycline (15 µg). Results were interpreted as Susceptible or Resistant using CLSI breakpoints [15]. The Multiple Antibiotic Resistance (MAR) index was calculated for each isolate as a/b, where 'a' is the number of antibiotics to which the isolate was resistant and 'b' is the total number of antibiotics tested (10) [8, 15].

2.6. Statistical Analysis

Data were analyzed using GraphPad Prism v9.0. Prevalence was expressed as percentages. Descriptive statistics were used to summarize bacterial loads and resistance patterns.

3. RESULTS

3.1. Bacterial Load of Edible Plant Biota Samples from Kpiri-Kpiri Market

The total viable bacterial counts on the sampled fruits and vegetables from Kpiri-Kpiri Market ranged from 6.90×10^4 to 1.94×10^5 CFU/mL. Among the vegetables, Pumpkin Leaf had the highest contamination level at 1.94×10^5 CFU/mL, followed by Okro at 1.43×10^5 CFU/mL and African Pear at 1.20×10^5 CFU/mL. Among the fruits, Watermelon showed the highest bacterial load at 1.70×10^5 CFU/mL, followed by Banana at 1.09×10^5 CFU/mL. The mean bacterial load for all samples was 1.14×10^5 CFU/mL.

Table 1: Mean Bacterial Load of Raw Fruits and Vegetables from Kpiri-Kpiri Market

Sample Category	Sample Type	Number of Samples (n)	Mean Bacterial Load (CFU/mL)
Vegetables	Cucumber	4	1.22×10^5
	African Pear	4	1.20×10^5
	Garden Egg Fruit	4	8.00×10^4
	Fresh Tomato	4	9.80×10^4
	Fresh Pepper	4	8.40×10^4
	Okro	4	1.29×10^5
	Carrot	4	9.20×10^4
	Garden Egg Leaf	4	1.10×10^5
	Pumpkin Leaf	4	1.79×10^5
	Cabbage	4	8.30×10^4
Fruits	Tigernut	4	9.90×10^4
	Banana	4	1.09×10^5
	Watermelon	4	1.70×10^5
	Guava	4	6.90×10^4
	Palm Fruit	4	8.40×10^4
Overall Mean		**60**	**1.14×10^5**

3.2. Prevalence of *Campylobacter jejuni* in Fruits from Different Geographical Locations (Comparative Analysis)

Table 2 presents a comparative analysis of *C. jejuni* prevalence in fruits from different geographical locations worldwide.

Table 2: Prevalence of Campylobacter jejuni in Fruits from Different Geographical Locations (Comparative Analysis)

Location (Country/City)	Fruit Type(s) Tested	Number of Samples	Prevalence of *C. jejuni* (%)	Study (Year)
Abakaliki, Nigeria (Kpiri-Kpiri Market)	Watermelon, Guava, Banana, Tigernut, Palm Fruit	20	**5.0%** (1/20)	**Present Study (2026)**
Mymensingh, Bangladesh	Mixed fruits (watermelon, guava, banana)	50	8.0%	[16]
Mymensingh, Bangladesh	Fresh fruits (various types)	30	10.0%	[17]
Mekelle, Ethiopia	Ready-to-eat fruit juices	60	5.0%	[9]
Jimma, Ethiopia	Raw fruits (mixed)	50	0.0%	[18]
Tehran, Iran	Fresh fruits (retail)	80	2.5%	[19]
Beijing, China	Fresh-cut fruits	200	0.0%	[20]
Malaysia	Fresh fruits (retail)	100	3.0%	[21]
Canada	Fresh fruits (imported)	500	0.2%	[22]
United States	Fresh produce (fruits)	300	0.3%	[23]

3.3. Prevalence and Phenotypic Identification of *Campylobacter jejuni* in Kpiri-Kpiri Market

Of the 60 samples analyzed from Kpiri-Kpiri Market, *Campylobacter* species were isolated from 32 samples, giving an overall *Campylobacter* prevalence of 53.3%. Among these, presumptive *Campylobacter jejuni* (hippurate hydrolysis positive) was identified in 8 isolates, representing 25.0% of all *Campylobacter*-positive samples and 13.3% of the total samples analyzed (Table 3). The 8 *C. jejuni* isolates were obtained from pumpkin leaf (3 isolates), cabbage (1), African pear (1), fresh tomato (1), cucumber (1), and watermelon (1).

Table 3: Prevalence and Distribution of Campylobacter jejuni from Edible Plant Biota in Kpiri-Kpiri Market

Sample Source	Sample Type	Number of Samples (n)	*Campylobacter* spp. Positive (%)*	*C. jejuni* Positive (Hippurate +) (%)†	Prevalence of *C. jejuni* (%)‡
Vegetables	Pumpkin Leaf	4	4 (100%)	3 (75.0%)	75.0%
	Cabbage	4	2 (50.0%)	1 (25.0%)	25.0%
	African Pear	4	1 (25.0%)	1 (25.0%)	25.0%
	Fresh Tomato	4	2 (50.0%)	1 (25.0%)	25.0%
	Cucumber	4	2 (50.0%)	1 (25.0%)	25.0%
	Okro	4	2 (50.0%)	0 (0.0%)	0%
	Garden Egg Leaf	4	2 (50.0%)	0 (0.0%)	0%
	Garden Egg Fruit	4	1 (25.0%)	0 (0.0%)	0%
	Fresh Pepper	4	1 (25.0%)	0 (0.0%)	0%
	Carrot	4	1 (25.0%)	0 (0.0%)	0%
Subtotal (Vegetables)		**40**	**18 (45.0%)**	**7 (17.5%)**	**17.5%**
Fruits	Watermelon	4	3 (75.0%)	1 (25.0%)	25.0%
	Banana	4	2 (50.0%)	0 (0.0%)	0%
	Tigernut	4	2 (50.0%)	0 (0.0%)	0%
	Palm Fruit	4	4 (100%)	0 (0.0%)	0%
	Guava	4	3 (75.0%)	0 (0.0%)	0%
Subtotal (Fruits)		**20**	**14 (70.0%)**	**1 (5.0%)**	**5.0%**
Total		**60**	**32 (53.3%)**	**8 (13.3%)**	**13.3%**

3.4. Antimicrobial Resistance Profile of *Campylobacter jejuni* Isolates

Table 4 shows the antibiotic susceptibility profile of *Campylobacter jejuni* isolates from vegetable samples (n=7). The results show a very high prevalence of resistance to Ceftazidime (100%), Cefotaxime (100%), Cefoxitin (100%), Meropenem (100%), and Tetracycline (100%). Furthermore, a high percentage of isolates were resistant to Nitrofurantoin (71.4%), Imipenem (57.1%), and Erythromycin (42.9%). In contrast, all isolates (100%) were susceptible to Ciprofloxacin and Gentamicin.

Table 4: Antibiotic Susceptibility Profile of Campylobacter jejuni Isolates from Vegetable Samples (n=7)

Class	Antibiotics (μg)	Resistance (%)	Susceptible (%)
Cephalosporin	Ceftazidime (30)	7 (100)	0 (0.0)
	Cefotaxime (30)	7 (100)	0 (0.0)
	Cefoxitin (30)	7 (100)	0 (0.0)
Carbapenem	Imipenem (10)	4 (57.1)	3 (42.9)
	Meropenem (10)	7 (100)	0 (0.0)
Flouroquinolone	Ciprofloxacin (5)	0 (0.0)	7 (100)
Aminoglycoside	Gentamicin (15)	0 (0.0)	7 (100)
Nitrofuran	Nitrofurantoin (25)	5 (71.4)	2 (28.6)
Macrolide	Erythromycin (15)	3 (42.9)	4 (57.1)
Folate inhibitor	Tetracycline (15)	7 (100)	0 (0.0)

Key: *n = 7 (Number of C. jejuni isolates from vegetable samples)*

Table 5 shows the antibiotic susceptibility profile of *Campylobacter jejuni* isolates from fruit samples (n=1). The results show that the single isolate demonstrated 100% resistance to Ceftazidime, Cefotaxime, Cefoxitin, and Tetracycline, while remaining fully susceptible (100%) to Ciprofloxacin and Gentamicin.

Table 5: Antibiotic Susceptibility Profile of Campylobacter jejuni Isolates from Fruit Samples (n=1)

Class	Antibiotics (µg)	Resistance (%)	Susceptible (%)
Cephalosporin	Ceftazidime (30)	1 (100)	0 (0.0)
	Cefotaxime (30)	1 (100)	0 (0.0)
	Cefoxitin (30)	1 (100)	0 (0.0)
Carbapenem	Imipenem (10)	0 (0.0)	1 (100)
	Meropenem (10)	0 (0.0)	1 (100)
Flouroquinolone	Ciprofloxacin (5)	0 (0.0)	1 (100)
Aminoglycoside	Gentamicin (15)	0 (0.0)	1 (100)
Nitrofuran	Nitrofurantoin (25)	0 (0.0)	1 (100)
Macrolide	Erythromycin (15)	0 (0.0)	1 (100)
Folate inhibitor	Tetracycline (15)	1 (100)	0 (0.0)

Key: *n = 1 (one C. jejuni isolate from fruit samples).*

Table 6 shows the combined antibiotic susceptibility profile of all *Campylobacter jejuni* isolates (n=8). The results show a very high prevalence of resistance to Ceftazidime (100%), Cefotaxime (100%), Cefoxitin (100%), Meropenem (87.5%), and Tetracycline (100%). Furthermore, resistance was observed to Nitrofurantoin (62.5%), Imipenem (50.0%), and Erythromycin (37.5%). In contrast, all isolates (100%) were susceptible to Ciprofloxacin and Gentamicin.

Table 6: Antibiotic Susceptibility Profile of Campylobacter jejuni Isolates from All Samples (n=8)

Class	Antibiotics (µg)	Resistance (%)	Susceptible (%)
Cephalosporin	Ceftazidime (30)	8 (100)	0 (0.0)
	Cefotaxime (30)	8 (100)	0 (0.0)
	Cefoxitin (30)	8 (100)	0 (0.0)
Carbapenem	Imipenem (10)	4 (50.0)	4 (50.0)
	Meropenem (10)	7 (87.5)	1 (12.5)
Flouroquinolone	Ciprofloxacin (5)	0 (0.0)	8 (100)
Aminoglycoside	Gentamicin (15)	0 (0.0)	8 (100)
Nitrofuran	Nitrofurantoin (25)	5 (62.5)	3 (37.5)
Macrolide	Erythromycin (15)	3 (37.5)	5 (62.5)
Folate inhibitor	Tetracycline (15)	8 (100)	0 (0.0)

Key: *n = 8 (Total number of C. jejuni isolates from all samples)*

3.5. Multiple Antibiotic Resistance (MAR) Index

The Multiple Antibiotic Resistance (MAR) Index was calculated for each *C. jejuni* isolate using the formula: MAR Index = a/b, where 'a' is the number of antibiotics the isolate was resistant to, and 'b' is the total number of antibiotics tested (10) [8, 15]. Table 7 presents the MAR indices for all eight isolates along with the specific antibiotics each isolate resisted.

Table 7: Multiple Antibiotic Resistance (MAR) Index of *Campylobacter jejuni* Isolates from Kpiri-Kpiri Market, Showing Specific Antibiotics Resisted

Table 7: Multiple Antibiotic Resistance (MAR) Index of Campylobacter jejuni Isolates from Kpiri-Kpiri Market, Showing Specific Antibiotics Resisted

Isolate Code	Sample Source	Antibiotics Resisted (n=10 antibiotics tested)	Number Resistant (a)	MAR Index (a/10)
CV-KK-1	Pumpkin Leaf	CAZ, CTX, FOX, IPM, MEM, NIT, TET	7	0.70
CV-KK-2	Pumpkin Leaf	CAZ, CTX, FOX, MEM, NIT, TET	6	0.60
CV-KK-3	Pumpkin Leaf	CAZ, CTX, FOX, MEM, NIT, TET	6	0.60
CV-KK-4	Cabbage	CAZ, CTX, FOX, MEM, NIT, TET	6	0.60
CV-KK-5	African Pear	CAZ, CTX, FOX, MEM, NIT, TET	6	0.60
CV-KK-6	Fresh Tomato	CAZ, CTX, FOX, MEM, NIT, TET	6	0.60
CV-KK-7	Cucumber	CAZ, CTX, FOX, MEM, NIT, TET	6	0.60
CF-KK-1	Watermelon	CAZ, CTX, FOX, ERY, TET	5	0.50
Mean			**6.0**	**0.60**

Key: *CAZ = Ceftazidime, CTX = Cefotaxime, FOX = Cefoxitin, IPM = Imipenem, MEM = Meropenem, NIT = Nitrofurantoin, ERY = Erythromycin, and TET = Tetracycline.*
A MAR index greater than 0.2 is widely accepted as an indication that isolates originate from a high-risk environment where antibiotics are frequently used [8, 15]. The mean MAR index of 0.60 observed in this study significantly exceeds the 0.2 threshold, indicating that these C. jejuni isolates originated from high-risk contamination sources with significant antibiotic pressure.

4. DISCUSSION

This study provides critical baseline data on the contamination of edible plant biota with *Campylobacter jejuni* in Kpiri-Kpiri Market, Abakaliki Metropolis, Nigeria. The total bacterial loads observed in this study ranged from 6.90 × 10^4 to 1.94 × 10^5 CFU/mL, with a mean of 1.14 × 10^5 CFU/mL, indicating a high level of microbial contamination across all produce types. The highest bacterial loads were observed in Pumpkin Leaf (1.94 × 10^5 CFU/mL) and Watermelon (1.70 × 10^5 CFU/mL). This finding is consistent with the understanding that leafy greens and fruits with soft rinds are more susceptible to microbial attachment and proliferation due to their large surface area and topographical features that facilitate bacterial adhesion [7].

The overall prevalence of *Campylobacter* species (53.3%) in Kpiri-Kpiri Market is alarmingly high. At 13.3% of total samples, the prevalence of *C. jejuni* poses a significant public health risk. While this figure aligns with the isolation rates reported by Abdullah-Al-Mamun *et al.* [16] in Bangladesh, it substantially exceeds the 5–10% range documented in Ethiopian research [9]. The higher prevalence in the present study may be attributed to several factors prevalent in open markets like Kpiri-Kpiri, including open display of produce exposing them to dust and flies, poor handling practices by vendors, inadequate storage facilities, and the likely use of untreated animal manure as fertilizer during cultivation [9,24].

The isolation of *C. jejuni* from seven different vegetable types (pumpkin leaf, cabbage, African pear, fresh tomato, cucumber) and one fruit (watermelon) indicates widespread contamination across diverse produce types. The highest prevalence among vegetables was observed in pumpkin leaf (75.0%), which is particularly concerning given that leafy vegetables are often consumed raw in salads. The isolation of *C. jejuni* from watermelon (25.0% prevalence among watermelon samples) demonstrates that fruits are not exempt from contamination risk.

The prevalence of *C. jejuni* in fruits from Kpiri-Kpiri Market (5.0%) compares variably with findings from other regions globally (Table 2). The 5.0% prevalence observed in the present study is comparable to the 5.0% reported from ready-to-eat fruit juices in Mekelle, Ethiopia [9], but lower than the 8-10% prevalence reported in Bangladesh [16,17]. In contrast, studies from developed nations report considerably lower prevalence rates, including 0.2% in Canada [22] and 0.3% in the United States [23].

Similarly, studies from China [20] and Iran [19] recorded 0.0% and 2.5%, respectively, while a Malaysian study reported 3.0% [21]. Even within the same continent, significant geographical variability exists; for instance, one Ethiopian study from Jimma town reported 0% prevalence in raw fruits [18]. The higher prevalence observed in the present study compared to developed nations can be attributed to several factors prevalent in open markets like Kpiri-Kpiri, including open display of produce exposing them to dust and flies, poor handling practices by vendors, inadequate cold chain infrastructure, and the widespread use of untreated animal manure as fertilizer during cultivation [9,24]. The complete absence of *C. jejuni* in some fruit types (guava, banana, tigernut, palm fruit) in the present study suggests that fruit surface characteristics (such as peel thickness and texture) may influence bacterial attachment and survival, consistent with findings from other studies showing that fruits with smooth, intact peels are less likely to harbor enteric pathogens [7].

The antimicrobial resistance profile of the *C. jejuni* isolates from Kpiri-Kpiri Market is deeply concerning. The complete (100%) resistance to tetracycline observed in this study aligns with findings from other Nigerian research on *Campylobacter* from meat sources in Abakaliki [25]. This pattern directly implicates agricultural antibiotic use particularly in poultry production, where tetracyclines are widely employed for growth promotion and therapy as a primary driver of this resistance phenotype. The high rates of resistance to cephalosporins (100% to ceftazidime, cefotaxime, cefoxitin) and carbapenems (87.5% to meropenem, 50.0% to imipenem) are alarming, as these are critically important, last-resort antibiotics for treating multidrug-resistant Gram-negative infections in humans [26]. The detection of carbapenem resistance in *C. jejuni* from fresh produce sold in an open market is particularly worrisome and suggests the environmental dissemination of resistance genes, potentially through mobile genetic elements originating from agricultural sources where antibiotics are used intensively [12, 27, 28].

The finding of 100% susceptibility to ciprofloxacin and gentamicin is a notable and clinically useful finding, providing effective empirical treatment options for severe campylobacteriosis in this region. This pattern differs from studies in other regions where fluoroquinolone resistance in *C. jejuni* is high [29], suggesting that fluoroquinolones may still be viable treatment options in Abakaliki. The high MAR index (mean 0.61, well above the 0.2 high-risk threshold) confirms that these *C. jejuni* strains originate from environments with intense antibiotic selection pressure [13, 30]. All isolates had MAR indices exceeding 0.5, indicating that they originated from high-risk sources where antibiotics are frequently used [31], such as poultry farms or agricultural settings with routine antibiotic administration.

5. CONCLUSION

This study conclusively demonstrates that edible plant biota specifically raw fruits and vegetables sold in Kpiri-Kpiri Market, Abakaliki Metropolis, are significantly contaminated with multidrug-resistant *Campylobacter jejuni*. The substantial prevalence of this pathogen on fresh produce, coupled with alarming resistance to multiple critically important antibiotics, poses a grave public health threat to consumers in Abakaliki. The preservation of susceptibility to certain key antibiotics, however, offers a temporary therapeutic window. Furthermore, the elevated multiple antibiotic resistance (MAR) index indicates that contamination originates from high-risk sources characterized by significant antibiotic pressure. These findings underscore the urgent need for targeted interventions in Kpiri-Kpiri Market to protect consumer health.

6. RECOMMENDATIONS

Based on the findings from Kpiri-Kpiri Market, the following recommendations are made:

1. Market Authorities (Kpiri-Kpiri Market Management): Implement improved sanitation facilities within the market, including provision of clean water for washing produce and handwashing stations for vendors. Enforce proper waste disposal to reduce fly and pest infestation.

2. Vendors in Kpiri-Kpiri Market: Vendors should be educated on good hygienic practices, including regular handwashing, using clean display surfaces, covering produce to reduce dust and fly contamination, and separating raw produce from potentially contaminated materials.

3. Regulatory Bodies (Ebonyi State Ministry of Health, NAFDAC): Conduct regular surveillance of foodborne pathogens and AMR patterns in Kpiri-Kpiri Market. Implement educational campaigns for farmers supplying the market on the risks of using untreated manure and the importance of good agricultural practices.

4. Consumers: Consumers purchasing from Kpiri-Kpiri Market should thoroughly wash all raw fruits and vegetables under clean running water before consumption. Peeling, where applicable, and cooking remain the most effective methods to eliminate pathogens.

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