ISSN: 2347-467X, Vol. 07, No. (3) 2019, Pg. 905-917

Current Research in Nutrition and Food Science

www.foodandnutritionjournal.org

Prevalence Rate, Antibiotic Resistance and Biotyping of Thermotolerant *Campylobacter* Isolated from Poultry Products Vended in Wasit Markets

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Abstract

Campylobacter is a public cause of globally identified human gastrointestinal disease. Nonetheless, in Iraq many sides of the epidemiology of Campylobacteriosis and its impact on public health remain poorly understood. Hence, this study was taken to offer reference information on the prevalence rate, sensitivity to antibiotics and biotyping of *Campylobacter* in poultry products sold in the Wasit markets. A total of 85 samples were collected including chicken (n = 45) and turkey (n =40) meat were surveyed for isolation and identification. Thermotolerant *Campylobacter* was detected in 54 samples by which *Campylobacter jejuni* (*C. jejuni*) was recognized as a main species accounting for 37(68.5%),while *Campylobacter coli* (*C.coli*) had 17 (31.5%) of the positive samples. Highest resistance was perceived to oxacillin and tetracycline as (94.4% and 85.2%), respectively. While lowest rate of resistance, 29.6% was detected against gentamicin. *Campylobacter coli* isolates showed higher resistance rate than *C. jejuni* isolates towards the selected antibiotics. In addition, multiple drug resistance (MDR) to at least three antibiotics was detected in the vast majority (90.7%) of the experienced isolates. Forty- three (79.6%) of the isolates had multiple antibiotic resistance index (MAR-index) 0.4 and above. Results of biotyping showed that biotype I was the predominant biotype in the two species as 70.2 and 76.5 proportions in *C. jejuni* and *C.coli*, respectively. Our results proposed that the presence of *Campylobacter* in poultry with greater resistance to erythromycin and/ or ciprofloxacin triggers the public health alarm and accentuates the education of consumers on the quality and safety of such foods.

Article History

Received: 9 March 2019
Accepted: 10 September 2019

Keywords

Biotyping;
C.coli;
C. jejuni;
Chicken Meat;
Multiple Drug Resistance;
Turkey Meat.

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Doi: http://dx.doi.org/10.12944/CRNFSJ.7.3.29

Introduction

Campylobacter is considered as a principal cause of gastroenteritis in humans responsible for approximately 166 million diarrheal cases and 37,600 deaths per year globally.[1] In addition to gastrointestinal infections, Campylobacteriosis is the best predisposing factor of Guillain-Barré syndrome, a serious demyelinating neuropathy, which roughly occurs in 3/10 000 cases of *Campylobacter* infections.[2] Thermotolerant *Campylobacter* which has a clinical significance due to the consumption of meat and meat products are C.*jejuni* and its closely connected *C.coli* represents more than 90% of human infections.[3] The natural reservoirs of *Campylobacter* spp. are intestinal tracts of domesticated and wild birds and mammals. The consumption or the mishandling with raw or undercooked meat in particular poultry meat is considered to be the major risk factors for human Campylobacteriosis.[4] In general, self-limiting infection with *Campylobacter* does not necessitate therapeutic involvement, but in patients with severe cases or insufficiencies in the immunity response medical cure should be considered.[2] The drugs of choice used in the medical cure of *Campylobacter*iosis are azithromycin, erythromycin, and ciprofloxacin.[4] While tetracyclines could be considered an alternative option in the cure of *Campylobacter* infection.[4,5]

Campylobacter becomes extra resistant to antibiotics and several strains sophisticated MDR to various medications.[6] Multi-resistant *Campylobacter* exclusively against quinolones and erythromycin, has increased universally and has generated global alarms since these are the chief particles for the treatment of infection by *Campylobacter.*[7, 8] Contaminated foods of animal origin with resistant *Campylobacter* strains to antibiotics harbour a significant hazard to public health.[4]

As the incidence of the infection has increased, there is an urgent need to take measures to identify the source of the bacterium.[9] Biotyping methods aid in categorization of strains recovered from human, birds and on bird produces and permit to evaluate these strains at the species and subspecies points. Documentation of these strains offers researchers the capability toward analyze pathogenesis of contagions, perceive as well as scrutinize epidemics, support surveillance then avoidance infection in humans.[9]

In our country, poultry meat is measured as the best prevalent food in most residents and as far as we know, there are no available documents on the presence of *Campylobacter* spp. in Wasit poultry products, so the current study was undertaken to investigate the prevalence, antimicrobial resistance, and biotyping of *C. jejuni* and *C.coli* in two kinds of poultry products (chicken meat and turkey meat) which would assist in the microbiological and epidemiological evaluation of these vended products at consumer level in our markets.

Materials and Methods

Ethical Approval

Not essential for this style of study. Poultry meat were vended from the markets.

Collection and Treating of Poultry Meat

From August to December 2018, a total of 85 samples of poultry meat, comprising chicken thighs (n = 45) and turkey thighs (n = 40), were collected randomly from numerous superstores and retail supplies. The samples were collected in sterilized bag and transported to the laboratory with ice packets in 3 h. All samples were thawed in a refrigerator overnight and treated in 3 h.

Isolation and Identification of *Campylobacter*

Isolation of *Campylobacter* spp. was performed in accordance with the standard microbiological protocols,[10,11] with some modifications. Briefly samples were defrosted at 4°C for 18 h, then treated aseptically by weighing 20 g into a sterilized stomacher bag, and then 180 ml of Preston enrichment broth using the next preparation [Nutrient broth No.2 (Oxoid,CM0067); *Campylobacter* selective antibiotics (Oxoid,SR0204E); *Campylobacter* development supplement (Oxoid,SR0232E); lysed horse blood (Oxoid,SR0048C)] was added and stomached for 2 min. Following selective enhancement at 42°C for 18 h, 20 µl of enrichment broth was streaked on to plates of modified Charcoal Deoxycholate agar (mCCDA)(Oxoid, CM 739) enhanced with mCCDA antibiotic (Oxoid ,SR155) and raised under microaerophilic condition (O_2 5 %, CO_2 10 %, N_2 85 %) inside an anaerobic jar at 42°C for 72 h. Colonies demonstrating typical morphology of *Campylobacter* on mCCDA (greyish, smooth and moistened, spreading trend, film like transparent growth) were purified through culturing onto mCCDA agar base deprived of enhancement, then conserved in Trypton Soya Broth (Oxoid,CM0129) supplemented by 20% (v/v) pure glycerin at deep freezing.[12] Further identification based on biochemical reactions (wet mount slide test, oxidase activity and, microaerobic growing at diverse temperatures) was performed.[10,11] For the identification of thermotolerant *Campylobacter*, the bioMérieux API® identification kit API CAMPY (BIOMERIEUX, 20800) was adopted. Biotyping of the isolates was performed using Lior scheme,[13] based on rapid H_2S production in a semisolid agar complemented via using *Campylobacter* growing enhancement (Oxoid, SR 0232E), DNase test and, hippurrate hydrolysis test.[13]

Antibiotic Resistance of Thermotolerant *Campylobacter*

The disc diffusion technique on Mueller-Hinton agar (Oxoid, CM0337) complemented by 5% lysed horse blood (SR0048C), was used to detect the sensitivity to antibiotics in *Campylobacter* isolates.[14] Interpretation of results was done according to the Clinical and Laboratory Standards Institute (CLSI).[15] In summary, bacterial growth recovered from freezing cultures were grown on mCCDA base deprived of enhancement for 24 h at 42°C under microaerophilic conditions. A method was implemented in which the inoculum was made through direct suspending of isolated colonies in broth. This approach has been recommended to check demanding bacteria for instance *Campylobacter.*[14] Sterilized swabs were exploited to uniformly distribute the inoculum on agar plates. The selected antimicrobials were nalidixic acid (ND) 30 µg, ciprofloxacin (CIP) 5 µg, erythromycin (E) 15 µg, tetracycline (T) 30 µg, gentamicin (GM) 10 µg, ofloxacin (OFL) 5 µg, oxacillin (OX) 1 µg and vancomycin (VAN) 30 µg .The petri dishes were raised in microaerobic conditions at 42°C overnight.[14]

Multiple Antibiotic Resistance (MAR index)

The MAR index of isolates was detected as the proportion between the numeral of multiple antibiotics to which the recovered isolates are resistant to the numeral of multiple antibiotics to which the specific isolates are exposed.[16]

Statistics

Data analysis were performed by MedCalc Software bvba version 18 (BE,USA). Two samples Chi-square (χ^2) between proportions was used to compare significance between proportions with a 5% significant level https://www.medcalc.org/.

Results

Our study carried out to inspect the prevalence of thermotolerant *Campylobacter* in poultry meat vended in Wasit marketplaces. The results (Table 1) showed that the prevalence of thermotolerant *Campylobacter* in poultry meat was (63.5%) of those (68.5% and 31.5%) were identified as C.*jejuni* and *C.coli* respectively. Moreover, with regard to the *Campylobacter* species, chicken meat had the highest prevalence for C.*jejuni* (81.5%), whereas turkey meat had the highest prevalence for *C.coli* (44.4%). Statistically, there is no significant effect ($p>0.05$) on the prevalence of *Campylobacter* based on sample type (χ^2 = 0.508, p=0.476), but with regard to the *Campylobacter* species, there is a significant effect ($p<0.05$) on the prevalence of C.*jejuni* and *C.coli* based on sample type (χ^2= 0.600, p=0.0102).

Table 1: Prevalence of *Campylobacter* spp. in poultry meat vended in Wasit markets

Sample's type	No. of samples tested	n/N (%) *Campylobacter* spp.	n/N (%) *C.jejuni*	n/N (%) *C.coli*
Chicken meat	45	27/45 (60)	22/27 (81.5)	5/27 (18.5)
Turkey meat	40	27/40 (67.5)	15/27 (55.6)	12/27 (44.4)
Total	85	54/85 (63.5)	37/ 54 (68.5)	17/54 (31.5)
P value		P =0.4760	P =0.0102	P =0.0102

n=number of positive samples, N= number of tested samples, %= percentage.

Antibiotic Resistance

The results (Table 2) showed that high proportion of the experienced isolates displayed resistance to OX, T, VAN and E with prevalence of (94.4%, 85.2%,74.1% and 72.2%), respectively. While the resistance against fluoroquinolones (ND, CIP and, OFL) is moderate up to 50% by which *C.coli* isolates presented a high prevalence of resistance (up to 80%) than *C. jejuni* against these antibiotics. On the other hand, our results showed that GM had the lowest prevalence (29.6%) of resistance in the tested isolates. Moreover, based on *Campylobacter* species and regardless of the type of samples, our results presented great prevalence of resistance in *C.coli* than in *C. jejuni* for entirely scrutinized antibiotics (Figure 1), but taken into consideration the type of sample, our results publicized high prevalence of resistance against the screened antibiotics in turkey *Campylobacter* isolates than in chicken *Campylobacter* isolates (Figure 2). Statistically and according to the *Campylobacter* species (*C. jejuni* and *C.coli*), there is a significant effect ($p < 0.05$) in the level of resistance observed only towards the CIP ($\chi^2 = 4.1143$, $p = 0.041$). According to the type of sample, there is no significant effect ($p > 0.05$) for the sample type on the prevalence of resistance to the selected antibiotics (p = 0.175, 0.414, 0.414, 0.763, 0.448, 0.237, 0.556 and 0.538) for (ND, CIP, OFL, E, T, GM, OX and, VAN), respectively.

Table 2: Prevalence of antibiotic resistance in *Campylobacters* spp. recovered from poultry meat vended in Wasit markets

Antibiotics	Prevalence of antibiotic resistance in *Campylobacters*				
	Sample's type				
	Chicken		Turkey		
	C.jejuni n/N (%)	*C.coli* n/N (%)	*C.jejuni* n/N (%)	*C.coli* n/N (%)	Total n/ N (%)
Nalidixic acid	7/22 (31.8)	3/5 (60)	8/15 (53.3)	7/12 (58.3)	25/54 (46.3)
Ciprofloxacin	8/22 (36.4)	4/5 (80)	7/15 (46.7)	8/12 (66.7)	27/54 (50)
Ofloxacin	9/22 (40.9)	3/5 (60)	8/15 (53.3)	7/12 (58.3)	27/54 (50)
Erythromycin	15/22 (68.2)	4/5 (80)	11/15 (73.3)	9/12 (75)	39/54 (72.2)
Tetracycline	18/22 (81.9)	4/5 (80)	13/15 (86.7)	11/12 (91.7)	46/54 (85.2)
Gentamycin	4/22 (18.2)	2/5 (40)	5/15 (33.3)	5/12 (41.7)	16/54 (29.6)
Oxacillin	20/22 (90.9)	5/5 (100)	14/15 (93.3)	12/12 (100)	51/54 (94.4)
Vancomycin	17/22 (77.3)	4/5 (80)	10/15 (66.7)	9/12 (75)	40/54 (74.1)

n/N = The number of resistant isolates /the number of tested isolates, %= percentage

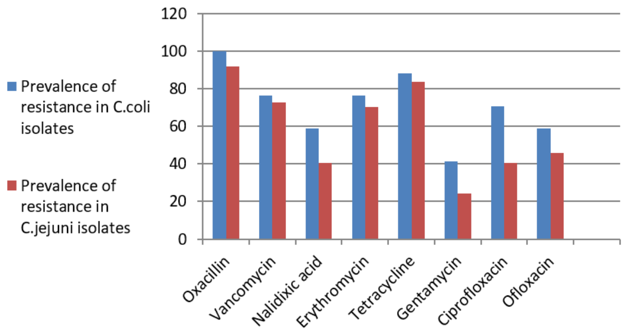

Fig. 1: Prevalence of resistance in *Campylobacter* isolates based on species

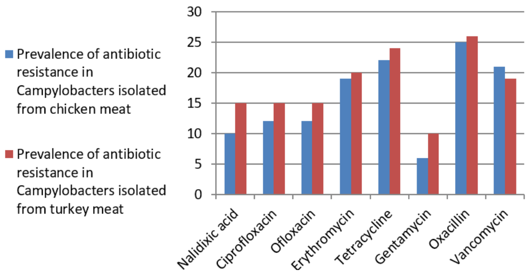

Fig. 2:Prevalence of resistance in *Campylobacter* isolates based on type of sample

Antibiotic resistance patterns (ARP) and MAR index of *C. jejuni* and *C.coli* isolates were surveyed and the results are presented in (Table 3). The obtainable results showed that 51(94.4%) of the tested isolates displayed resistance to one or more antimicrobials by which these isolates demonstrated 15 ARP. The results also showed that the vast majority (90.7%) of the experienced isolates demonstrated MDR toward as a minimum three antibiotics with MDR of (NA CIP OFL E T GM OX VAN) is the chief resistance model which apparent in 27.8% of the tested isolates. One of the most important observations of this study is that the prevalence of MDR with seven and eight antibiotics is more common in turkey *Campylobacter* isolates, counting the MDR model (NA CIP OFL ET GM OX VAN) as the only model reported in 9 (16.7%) of 54 isolates.

Table 3: Antibiotic resistance patterns and MAR index of thermotolerant *Campylobacter* recovered from poultry meat vended in Wasit markets

ARP	No. of antimicrobials	No. of antimicrobial classes	Sample's type				Total n/54 (%)	MAR index
			Chicken		Turkey			
			C.jejuni n/22 (%)	*C.coli* n/5 (%)	*C.jejuni* n/15 (%)	*C.coli* n/12 (%)		
(NA CIP OFL E T GM OX VAN)	8	6	4 (18.1)	2 (40)	4 (26.7)	5 (41.7)	15 (27.8)	1
(NA CIP OFL E T OX VAN); (NA CIP OFL E T GM OX)	7	5	2 (9.1)	0 (0)	3 (20)	2 (16.7)	7 (13)	0.9
(CIP OFL E T OX VAN); (NA OFL E T OX VAN)	6	5	1 (4.5)	1 (20)	1 (6.7)	0 (0)	3 (5.6)	0.8
(NA OFL T OX VAN); (CIP OFL E T OX); (NA E T OX VAN); (CIP E T OX VAN)	5	4;5	2 (9.1)	1 (20)	0 (0)	1 (8.3)	4 (7.4)	0.6
(E T OX VAN)	4	4	6 (27.2)	0 (0)	2 (13.3)	0 (0)	8 (14.8)	0.5
(T OX VAN); (E OX VAN); (E T OX)	3	3	2 (9.1)	0 (0)	2 (13.3)	2 (16.7)	6 (11.1)	0.4
(OX VAN); (CIP OX)	2	2	3 (13.6)	1 (20)	1 (6.7)	1 (8.3)	6 (11.1)	0.3
(T); (OX)	1	1	0 (0)	0 (0)	1 (6.7)	1 (8.3)	2 (3.7)	0.1
15	8						51 (94.4)	

NA= nalidixic acid, CIP= ciprofloxacin, OFL= ofloxacin, E= erythromycin, T= tetracycline, GM= gentamycin, OX= oxacillin, VAN= vancomycin, MAR index= multiple- drug resistance index, n= number of resistant isolates, ARP= Antibiotic resistance patterns.

Additionally, prevalence of *Campylobacter* isolates recorded MAR index 0.1, 0.3, 0.4,0.5,0.6,0.8,0.9 and 1 were 3.7%,11.1%, 11.1%, 14.8%, 7.4%, 5.6%, 13% and 27.8%, respectively (Table 3).

Biotyping of *Campylobacter*

Biotyping of thermotolerant *Campylobacter* recovered from poultry meat was experienced, and the results offered in (Table 4). *Campylobacter jejuni* and *C.coli* isolates showed a broad prevalence of biotype I (70.2% and, 76.5%), respectively. While the prevalence of biotype II, III and IV in *C. Jejuni* isolates was (16.2%, 8.1% and, 5.4%), respectively. In addition, four (23.5%) of 17 *C.coli* isolates displayed a prevalence of biotype II.

Table 4: Biotyping of thermotolerant *Campylobacter* recovered from poultry meat vended in Wasit markets

Sample's type	*C.jejuni* biotypes n/N (%)				*C.coli* biotypes n/N (%)	
	I	II	III	IV	I	II
Chicken meat	17/22 (77.3)	4/22 (18.1)	1 /22 (4.5)	_	4/5 (80)	1/5 (20)
Turkey meat	9/15 (60)	2/15 (13.3)	2 /15 (13.3)	2/15 (13.3)	9/12 (75)	3/12 (25)
Total n/N (%)	26/37(70.2)	6/37(16.2)	3/37(8.1)	2/37 (5.4)	13/17(76.5)	4/17(23.5)

n = number of positive isolates ; N= number of tested isolates, %= percentage.

Discussion

Pollution of poultry carcasses and then poultry meat at market outlets chiefly occurred throughout evisceration as well through scalding.[17] During treatment, the intestinal gut possibly leakage or rupture and the contents moved to the skin of the carcass, which delivers a proper environment aimed at the existence of *Campylobacter* spp. and later to cross contamination.[18] In addition, under frozen or storing conditions at refrigerator temperature, *Campylobacter* spp. can still be recovered and continued in chicken meat.[19] There are many opportunities for how this could happen. Though bacterial development is detained throughout low temperatures and part of them can be eliminated, but a proportion of these bacteria can persist or suffer serious injury,[20] and could be restored to become a viable but non-culturable pathogen (VBNC).[21] This may perhaps be the reply towards why *Campylobacter* was recovered from frozen meat at current study. Unfortunately, if poultry meat taken towards marketplaces is previously polluted or tainted throughout the practices previously being stored at low temperatures, the likelihoods of *Campylobacter* to persevere are still there. Although food products in supermarkets appear to be highly sanitized, the practices previously packaging can be pathogen-infested and the packaging conveniences themselves may be in a reduced situation. In another word, there is truly an opportunity of *Campylobacter* arising in this category of foodstuff as a result of cross adulteration. Rob *et al.,* found that the existing rate of *C. Jejuni* is 15 times better at 2°C than at 20°C.[22] So when we realize that chiller temperature is ranging from 4-16°C, so it possibly enhance the attendance of C.*jejuni* and *C.coli* then rise the opportunity of pollution.

The results of our study (Table 1) showed that 63.5% of poultry meat was positive for thermotolerant *Campylobacter* of those (68.5% and 31.5%) were identified as C.*jejuni* and *C.coli*, respectively. Similarly, Garin *et al.,*[2] and Kovalenko *et al.,*[24] detected *Campylobacter* in 65% and 60% of poultry samples, respectively. Moreover, they recovered *C. Jejuni* from 48.3% of the surveyed samples, that is lower than 68.5% achieved in the current study. Additionally, MAĆKIW *et al.,*[25] in Poland and Chokboonmongkol *et al.,*[26] in Thailand detected *Campylobacter* in 51.7% and 51% of raw poultry meat and broiler skin samples, respectively which are closely comparable with isolation percentage acquired in the existing investigation.

Lower prevalence rates than that described in our investigation were earlier achieved by Mäesaar *et al.,*[27] in Estonian who found that 20.8% of the trade poultry meat presented positive results to

Campylobacter by which *C. jejuni* and *C.coli* were found at a proportion of 43% and 13%, respectively. Awadallah *et al.,*[28] in Egypt recovered *Campylobacter* spp. from 25.9% and 47.5% of the inspected breast and thigh poultry samples, respectively.

The higher prevalence of this fastidious pathogen in our study may be a mirror to higher preliminary microbial counts and chromosomal variances among isolates which cause persistence and resistance to heat stress of *Campylobacter* spp. in food through storage.[29,30]

The higher prevalence rate of *Campylobacter* spp. from poultry products than that reported in the current study was formerly described in Argentina (83%),[18] UK (83.3%)[31] and, Nigeria (81.9%).[32] Additionally, previous studies conducted in Iraq found that the detection rates for *Campylobacter* spp. and C.*jejuni* in frozen chicken meat samples were (75% and 93.75 %) in provinces of Baghdad and Al-Muthanna, respectively.[33,34]

Our results indicated a large prevalence of *Campylobacter* in turkey than in chicken meat (Table1).This finding was in accordance with Luangtongkum *et al.,*[35] who accounted prevalence rate of *Campylobacter* spp. as (83.1%) and (65.8%) in turkeys and broilers, respectively. This study also displayed that *C. jejuni* was more prevalent than *C.coli* which detected in 68.5% of the positive samples. Numerous scientists noted the higher presence of *C. jejuni* than *C.coli* as Taylor[36] in USA, Rajendran *et al.,*[37] in India, and Deckert *et al.,*[38] in Canada and Mikulić *et al.,*[39] in Croatia. Reverse that, several workers including Awadallah *et al.,*[28] , Kanaan and Khashan[33], Kurinčič *et al.,*[40] and Rawat *et al.,*[41] reported the higher presence of *C.coli* than *C. jejuni*.

The variation in the prevalence of *C. jejuni* and *C.coli* could be due to the difference in the age of birds, the sampling season, the use of antibiotics, the variations in speciation approaches to discriminate these two pathogens and the incapability of some isolates to inhabit poultry have been shown to briefly choice for which of the two pathogens in some poultry herds.[36]

In addition, our outcomes showed a greater prevalence of *C.coli* (44.4%) in turkeys compared to chicken meat. The possible explanation for this result may be related to the growth period of the turkeys (18 weeks) compared to the chickens (6-8 weeks) and when the turkey is more tolerable in unfavorable environments than the chicken, which makes it a suitable host for *C.coli* since this pathogen is more resistant to the critical conditions than *C. jejuni.*[42] Furthermore, the use of β-lactams as growth supporters and the increase of antimicrobial resistance in *C.coli* may also be motivated by this prevalence.[6] Notwithstanding this variance, it is essential to realize as an entire superiority that thermotolerant *Campylobacter* in particular *C. jejuni* and *C.coli* are measured vital mediators of diarrhea and that the infected meat of poultry is predictable as a chief source of infection.[43]

It has been well documented that resistant *Campylobacter* was detected in animal species and in the food chain. The presence of resistant strains of *Campylobacter* to antibiotics in poultry may initiate its manifestation in poultry meat and their products, representing a threat to human wellbeing.[44]

The high prevalence of resistance toward antibiotics possibly resulted from mishandling of antibiotics in the growth period of poultry, particularly as growth complements and to avoid contagions.[45]

In the present study, *Campylobacter* isolated from retail poultry meat was highly resistant towards OX. In Thailand, 93% of *Campylobacter* isolates from vegetable farms and retail markets were found to be resistant to beta-lactams, which in accordance with our results.[46] This phenomenon may be related to the intrinsic resistance in *Campylobacter* to many beta-lactam drugs that make the use of these drugs not optimal, especially in severe infections.[16]

In the existing study, it has seen that *Campylobacter* isolates from retail poultry meat were highly resistant towards T, VAN and E. The expansive usage of T in human and veterinary medicines and as feed complements for poultry may be credited to the rise of high resistant organisms.[47] The selection of E resistance may be related to frequently usage of spiramycin for growth raise in poultry production.[48] Additionally, the multi-resistant bacteria inhabiting the poultry gut such as *Enterococci* spp. display resistance to several antibiotics through conveying numerous resistance genes, which can allocate resistance to *Campylobacter*.[48] Hence, poultry meat can be exposed to such resistant bacteria particularly vancomycin-resistant *Enterococci* (VRE). A study conducted in Turkey described that poultry meat was more frequently tainted with VRE among all samples of food with the prevalence of 57.1%.[49]

Our results were in accordance with other studies that presented high resistance of *Campylobacter* towards T up to 82% , 66.2% and 57.6% in Thailand, USA and Poland, respectively.[46,50,51] High level of resistance in *Campylobacter* isolates recovered from retail markets and chicken meat against VAN and E up to 86.7% was previously reported.[16,52] On the other hand, these findings are contradicted with other studies that demonstrate low levels of resistance to E, T and beta- lactams up to (9.4%,40.6%, and 31.2%), respectively.[26,40] Throughout the breeding period, poultry was routinely in contact with antimicrobials such as enrofloxacin and sarafloxacin, which could explain the emergence of quinolone resistance.[48]

Our results demonstrate a moderate resistance to quinolone that is consistent with previous USA result, they displayed that resistance to ND and CIP among *Campylobacter* isolates is up to (41% and 35%), respectively.[50] These results were contradictory with the Malaysian findings, they described that the resistance to enrofloxacin, norfloxacin and CIP among isolates of *Campylobacter* in retail markets is very low up to (1%).[16] They attributed low resistance to these antibiotics to small-scale vegetable production. On the other hand, the high prevalence of resistance in *Campylobacter* isolated from retail poultry and from raw meat against quinolones ranged from (86.6% -99%) based on other investigators.[51, 53] The use of untreated chicken dung as fertilizer has also been measured one of the factors contributing to the high resistance to quinolone in *Campylobacter* isolates.[16]

Apramycin has widely been used in a veterinary cure that may be related to the emergence of resistance to GM in *Campylobacter*s.[48] Our results publicized a low level of resistance among *Campylobacter* isolates to GM up to 29.6%. This finding in agreement with previous results documented in Iraq and Malaysia that reported a similar level of resistance in *Campylobacter* isolated from broiler meat to GM up to 26.7% and 22.4%, respectively.[33,54] On the other hand, a very low level of resistance to GM ranged from (0- 2%) was previously acquired.[16,50,51]

Based on our results, the resistance of these isolates varies relating to species of organisms and the origin of isolation with which the *C.coli* isolates display greater resistance proportions to the selected antibiotics than *C. jejuni*. On the other hand, isolates of *Campylobacter* from the turkey showed higher resistance rates than chicken isolates (Figure 1 and 2). This possibly linked to longer raising period for turkeys compared to chickens. Furthermore, since turkeys are further profitable than chickens, breeders are motivated to administer turkeys antibiotics for cure and avoidance of diseases and as growth complement.[50] These findings were in accordance with the previous results acquired in USA.[50]

Multidrug resistance (MDR) was identified as an isolate demonstrating resistance toward at least two antimicrobials concurrently.[55] The evolving of multi-resistance perhaps reveal gaining of single or diverse resistance factors on the similar DNA particle, such as multidrug pumps, that specify efflux activity against diverse antimicrobials.[56] The modes of genetic resistance might be chromosomal or plasmid-borne, and represent a combination of endogenous and picked up genes.[45] The resistance to two or more classes of antimicrobials has been perceived by other researchers.[16,45,51,55] Overall, MDR phenomenon to seven and eight antibiotics tended to be more ubiquitous in turkey *Campylobacter* isolates. These findings were in accordance with other researchers.[50,55] The detection of MDR *Campylobacter* especially towards CIP, E and GM in poultry meat had generated worldwide alarms as these particles are generally utilized in cure of man infections with *Campylobacter*.[50]

This study proposed that there are dissimilarities in husbandry practices used in the production period of these animals. This elucidates the dissimilarities in the MAR index between *Campylobacter* isolates found in poultry meat. As most antimicrobials administered through feed or water are not entirely absorbed in the intestine of the birds and up to 90% of the directed amount of particular drugs can be defecated in the faeces, so raw waste can be a vital resource of antimicrobial residues once utilized as fertilizer.[57] Thus, low MAR index would indicate that these isolates were recovered from meat were from low dangers of animal waste contamination.[16] And when these products were imported from various countries and from various origins so the farmers in these countries might be implemented different husbandry practices that postulate the dissimilarities in MAR index fluctuating from (0.1-1).

The results of our study presented a large prevalence of C.*jejuni* and *C.coli* biotype I. The identification of this biotype as the principal biotype is compatible with the preceding results reported in Nigeria and South of Chile found a large prevalence of biotype I in *C. jejuni* and *C.coli* isolates recovered from poultry meat and dairy cattle up to (60% and 68%), respectively.[32,58] It is clear from our results that isolates of poultry meat in this study displayed high prevailing of biotype I that is nearer to results acquired from humans by some authors.[13,59] Thus when we realize that biotype I is the most public biotype in human and biotype II is public in animals, so we will recognize the postulated function of these products as reservoirs of contagion to man. This fact is an alarm for the public health inferences.

Conclusion

In conclusion our data demonstrated that most tested isolates presented resistance to E and/or CIP with increase resistance towards GM. And since the consumption of diseased poultry meat may account for most human *Campylobacter*iosis cases, this information is alarming when realizing that these antibiotics are considered first-choice drugs for human infections. Our results proposed that the poultry industry could be the cause of a serious public health problem through the spread of pathogenic *Campylobacter* and resistance to antibiotics. These results highlight the necessity to monitor the occurrence and the MDR event of *Campylobacter* in animals, humans as well as in the food chain. Therefore, it is strongly recommended to implement particular control measures from farm to fork to enhance public fortification against Campylobacteriosis.

Acknowledgments

This study did not receive any fund or grant. The manuscript was written and supported by the authors.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Conflict of Interest

The authors declare they do not have any conflict of interest.

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