ANTIBIOTIC RESISTANCE OF *Salmonella* spp. ISOLATED FROM RETAIL CHICKEN MEAT IN SEREMBAN, N. SEMBILAN, MALAYSIA

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ABSTRACT. The rise in antibiotic resistance among *Salmonella* spp. is compromising the effectiveness of these medications and posing significant public health concerns. This study aims to evaluate the antibiotic susceptibility profiles of *Salmonella* spp. isolated from retail chicken meat and to assess their extended-spectrum beta-lactamase (ESBL) activity. A total of 110 samples were collected from 11 retail outlets, and *Salmonella* spp. presence was confirmed using conventional methods. Antibiotic susceptibility was tested against 18 antibiotics using the disk diffusion method, and ESBL production was assessed through the double-disc diffusion method. Descriptive statistics were employed for data analysis. *Salmonella* spp. was identified in 14 out of 110 samples (12.7%), with highest resistance against erythromycin (92.9%), followed by ampicillin (78.6%) while 71.4% were resistant to chloramphenicol, aztreonam, tetracycline, and trimethoprim-sulfamethoxazole. No resistance was found against amoxicillin-clavulanic acid, doxycycline, or ciprofloxacin. Resistance to the cephalosporins was noted; cefotaxime (35.7%), ceftazidime (21.4%), ceftriaxone (14.3%) and 21.4% to both cephalothin and cefepime. The Multiple Antibiotic Resistance (MAR) indices range from 0.06 to 0.67. Twelve isolates (85.7%) were resistant to three or more classes or antibiotics, with a substantial proportion (42.9%) resistant to five classes. Among the 12 MDR isolates, high resistance was observed in β-lactam antibiotics (100%), macrolides (91.7%) and the phenicols, tetracyclines, and co-trimoxazoles (83.3%). ESBL activity was detected in 85.7% isolates (n = 12), with highest resistance to erythromycin (n = 11), followed by ampicillin and aztreonam (n = 9 each). These findings highlight the need for continuous surveillance and epidemiological studies on their prevalence.

***Keywords*:** *Salmonella* spp., antibiotic susceptibility, extended-spectrum B-lactamase, retail chicken meat

INTRODUCTION

Foodborne illnesses are a major global concern, with *Salmonella* infections causing approximately 94 million cases of gastroenteritis and 155,000 deaths annually (Yang *et al*., 2019). It is estimated that *Salmonella* accounts for 19% of foodborne diseases related to poultry (O'Bryan *et al*., 2022). Reports of *Salmonella* prevalence in poultry products have been documented in Malaysia (Nidaullah et al., 2017; Shafini *et al*., 2017; Thung *et al*., 2016, 2018; Yoke-Kqueen *et al*., 2008). Over the past decade, antibiotic resistance in *Salmonella*, particularly among multidrug-resistant (MDR) strains, has increasingly posed a significant public health challenge (Fanissa, 2022; Tan *et al*., 2022). Studies have indicated a high prevalence of antibiotic resistance in *Salmonella* isolated from chicken meat (Tan *et al*., 2022). Furthermore, the emergence of MDR *Salmonella* strains producing extended-spectrum beta-lactamases (ESBLs) represents a critical issue in antimicrobial resistance. ESBLs enable bacteria to resist common beta-lactam antibiotics, such as penicillins and cephalosporins, making infections more difficult to treat. The presence of ESBL-producing *Salmonella* in poultry has been documented (Gambino *et al*., 2022; Ziech *et al*., 2016). This study aims to assess the antibiotic resistance profiles of *Salmonella* spp. isolated from retail chicken meat, focusing on multidrug-resistant strains and their ESBL activity.

MATERIALS AND METHOD

Isolation of *Salmonella* spp.

A total of 110 chicken meat samples were collected from 11 local meat retail markets in Seremban district, Malaysia in September 2016. The samples (10 from each retail market) were packed in sterile bags and transported to the laboratory under chilled temperature for further analysis. For pre-enrichment, each sample (25 g) and 225 mL 2% buffered peptone water (BPW) (Oxoid, Thermo Scientific, UK) were placed in sterile stomacher bag, homogenised for 2 min and incubated at 37 °C for 24 h. The pre-enrichment culture (0.1 mL) were pipetted into 10 mL Rappaport-Vassiliadis broth (RVB) (Oxoid, Thermo Scientific, UK) and incubated at 41.5 °C for 24 h. Aliquots of the incubated RVB cultures were streaked on xylose–lysine–deoxycholate (XLD) agar (Oxoid, Thermo Scientific, UK) using a loop, and each plate was incubated at 37 °C for 24 h. Presumptive pink colonies with or without black centres on XLD were detected as *Salmonella* and streaked separately on fresh XLD agar plates for biochemical examination.

Biochemical Confirmation of *Salmonella* spp.

Each presumptive *Salmonella* colony was confirmed biochemically by triple sugar iron (TSI) agar (Oxoid, Thermo Scientific, UK), urease (Oxoid, Thermo Scientific, UK), indole (Oxoid, Thermo Scientific, UK), lysine decarboxylase (Oxoid, Thermo Scientific, UK), β-galactosidase (Oxoid, Thermo Scientific, UK) and Voges-Proskauer (VP) (Oxoid, Thermo Scientific, Waltham, MA) tests. Colonies displaying a red slant (alkaline) and yellow butt (acidic) on TSI agar, along with H_2S production (black precipitate), gas production (evidenced by bubbles or cracking in the butt), negative urea utilisation (yellow), negative for indole production, positive for lysine decarboxylation (purple, alkaline), negative for β-galactosidase reaction (yellow) and negative for VP test were considered *Salmonella*-positive. Isolates presumptive of *Salmonella* for all tests were cultured on nutrient agar (NA) (Oxoid, Thermo Scientific, UK). The grown cultures were stored in nutrient broth (NB) (Oxoid, Thermo Scientific, UK) containing 20% glycerol and stored at -20 °C. Working cultures were cultivated on NA plates (Oxoid, Thermo Scientific, UK) and incubated at 37 °C overnight.

Antimicrobial Susceptibility Test of *Salmonella* Isolates

The antimicrobial susceptibility test (AST) on 18 types of antibiotics were conducted on Mueller-Hinton (MH) agar (Merck, Darmstadt, Germany) following the Kirby–Bauer disc diffusion method (CLSI, 2015). Each positive isolate was cultured in 5 mL NB (Oxoid, Thermo Scientific, UK) and incubated at 37 °C for 4 h to achieve the 0.5 McFarland turbidity standard. The bacterial cell suspension was swabbed uniformly using sterilised cotton swab on the MH agar plate. The antibiotic discs (Oxoid, Thermo Scientific, UK) tested were gentamicin (GEN 10 µg), streptomycin (STR 25 µg), amoxicillin–clavulanic-acid (AMC 30 µg), ampicillin (AMP 10 µg), aztreonam (ATM 30 µg), cefepime (CPM 30 µg), cefotaxime (CTX 30 µg), ceftazidime (CAZ 30 µg), ceftriaxone (CRO 30 µg), cephalothin (CF 30 µg), sulfamethoxazole–trimethoprim (SXT 25 µg), erythromycin (E 15 µg), chloramphenicol (C 30 µg), ciprofloxacin (CIP 5 µg), enrofloxacin (ENR 5 µg), nalidixic acid (NA 30 µg), doxycycline (DOX 30 µg), tetracycline (TE 30 µg). The discs were applied aseptically onto the surface of the MH plates using antimicrobial susceptibility disc dispenser (Oxoid, Thermo Scientific, UK) with maximum six discs per plate. The plates were then inverted and incubated at 37 °C for 24 h. The diameter of the inhibition zone was

measured using vernier callipers and classified as susceptible, intermediate and resistant categories according to CLSI guidelines (CLSI, 2015).

Screening of ESBL Production by *Salmonella* spp.

Initial screening was performed using three antibiotics; cefotaxime (CTX 30 µg), ceftazidime (CAZ 30 µg) and aztreonam (ATM 30 µg) (CLSI, 2015). Isolates with inhibition zone of any one of discs cefotaxime ≤27 mm, ceftazidime ≤22 mm, or aztreonam ≤27 mm were further analysed for the production of ESBL using double- disc diffusion method (Ziech *et al.,* 2016). A disc of amoxicillin-clavulanic acid (AMX/AC; 20/10 µg) was placed on the centre of MH agar plate seeded with *Salmonella* isolate. Each disc of cefepime (CPM 30 µg), cefotaxime (CTX 30 µg), ceftriaxone (CRO 30 µg) and ceftazidime (CAZ 30 µg) were dispensed within 25 to 30 mm apart around the AMX/AC disc. The MH plates were then incubated at 35 °C for 18 – 24 h. Isolates with any cephalosporin discs creating zones of inhibition towards the AMX/AC disc were interpreted as positive production of ESBL.

DATA MANAGEMENT AND ANALYSIS

The data were analysed using Microsoft Excel (2016). *Salmonella* isolates were further screened for susceptibility to 18 different antibiotics and classified as susceptible, intermediate or resistant based on the frequency and proportions. MDR was considered if one *Salmonella* isolate was resistant in three or more antibiotic classes. The Multiple Antibiotic Resistance (MAR) index was calculated by the formula: a/b; where a = represents the number of antibiotics to which a particular isolate was resistant to, and b = represents the total number of antibiotics tested (Krumperman, 1983).

RESULTS

Prevalence of *Salmonella* spp.

Table 1 shows that 12.7% (n = 14) of 110 total samples were detected with positive presence of *Salmonella* spp. from wings (15.8%), drumsticks (11.1%), breasts (20.0%) and ribs (9.7%). Among the parts, the highest detection rate was observed in wings (5.5%), followed by drumsticks (3.6%), ribs (2.7%), and breasts (0.9%).

Table 1. Isolation of *Salmonella* from chicken meat (n = 110)

Chicken part	No. of sample	No. of positive sample in chicken part (%)	No. of positive sample in total sample (%)
Wings	38	6 (15.8%)	6 (5.5%)
Drumsticks	36	4 (11.1%)	4 (3.6%)
Breasts	5	1 (20.0%)	1 (0.9%)
Ribs	31	3 (9.7%)	3 (2.7%)
Total	110	14 (12.7%)	14 (12.7%)

Antibiotic Resistance Profile of *Salmonella* spp.

Table 2 shows that 14 *Salmonella* isolates were resistant to 18 tested antibiotics, with the highest resistance to erythromycin (92.9%), followed by ampicillin (78.6%), while 71.4% were resistant to chloramphenicol, aztreonam, tetracycline, and trimethoprim-sulfamethoxazole. None of the isolates demonstrated resistance to amoxicillin-clavulanic acid, doxycycline, and ciprofloxacin. It was interesting to note that more than 14%

isolates showed resistance to three β-lactam of third generation of cephalosporins; namely cefotaxime (35.7%), ceftazidime (21.4%), and ceftriaxone (14.3%), while 21.4% were resistant to the first (cephalothin) and fourth (cefepime) generations. Notably, the results showed moderately low rates of resistance to enrofloxacin (7.1%).

Table 2. Antibiotic resistance profile of *Salmonella* spp. isolated from raw chicken meat (n = 14)

Class of Antibiotic	Antibiotic* (conc.)	No. of isolate (%)		
		Susceptible	Intermediate	Resistant
Aminoglycosides	GEN (10 µg)	9 (64.3%)	3 (21.4%)	2 (14.3%)
	STR (25 µg)	10 (71.4%)	0 (0.0%)	4 (28.6%)
β-lactams	AMC (30 µg)	12 (85.7%)	2 (14.3%)	0 (0.0%)
	AMP (10 µg)	3 (21.4%)	0 (0.0%)	11 (78.6%)
	ATM (30 µg)	4 (28.6%)	0 (0.0%)	10 (71.4%)
	CPM (30 µg)	11 (64.3%)	0 (0.0%)	3 (21.4%)
	CTX (30 µg)	3 (21.4%)	6 (42.9%)	5 (35.7%)
	CAZ (30 µg)	8 (57.1%)	3 (21.4%)	3 (21.4%)
	CRO (30 µg)	6 (42.9%)	6 (42.9%)	2 (14.3%)
	CF (30 µg)	9 (64.3%)	2 (14.3%)	3 (21.4%)
Co-trimoxazole	SXT (25 µg)	4 (28.6%)	0 (0.0%)	10 (71.4%)
Macrolides	E (15 µg)	0 (0.0%)	1 (7.1%)	13 (92.9%)
Phenicols	C (30 µg)	3 (21.4%)	1 (7.1%)	10 (71.4%)
Quinolones and fluoroquinolone	CIP (5 µg)	12 (85.7%)	2 (14.3%)	0 (0.0%)
	ENR (5 µg)	7 (50.0%)	6 (42.9%)	1 (7.1%)
	NA (30 µg)	3 (21.4%)	6 (42.9%)	5 (35.7%)
Tetracyclines	DOX (30 µg)	6 (42.9%)	8 (57.1%)	0 (0.0%)
	TE (30 µg)	4 (28.6%)	0 (0.0%)	10 (71.4%)

* gentamicin (GEN 10 µg), streptomycin (STR 25 µg), amoxicillin–clavulanic-acid (AMC 30 µg), ampicillin (AMP 10 µg), aztreonam (ATM 30 µg), cefepime (CPM 30 µg), cefotaxime (CTX 30 µg), ceftazidime (CAZ 30 µg), ceftriaxone (CRO 30 µg), cephalothin (CF 30 µg), sulfamethoxazole–trimethoprim (SXT 25 µg), erythromycin (E 15 µg), chloramphenicol (C 30 µg), ciprofloxacin (CIP 5 µg), enrofloxacin (ENR 5 µg), nalidixic acid (NA 30 µg), doxycycline (DOX 30 µg), tetracycline (TE 30 µg).

A total of 12 resistance patterns were observed among the *Salmonella* isolates (Table 3), with the predominant resistance pattern being erythromycin (E) (n = 2) and C+AMP+ATM+TE+SXT+E (n = 2). The MAR index ranged from 0.06 to 0.67, with the highest value of 0.67 (n = 2).

Table 3. Resistance patterns of *Salmonella* spp. and the respective MAR index (n = 14)

Resistance pattern*	No. of isolate	MAR Index**
E	2	0.06
C+AMP+ATM+E	1	0.22
CTX+TE+NA+E	1	0.22
G+C+AMP+TE+SXT+E	1	0.33
C+AMP+ATM+TE+SXT+E	2	0.33
S+AMP+ATM+TE+SXT+E	1	0.33
S+C+AMP+ATM+TE+SXT+E	1	0.38
C+AMP+CTX+CRO+ATM+TE+SXT+E	1	0.44
C+AMP+KF+CTX+ATM+NA+ENR+SXT+E	1	0.50
C+AMP+CTX+CRO+FEP+CAZ+ATM+TE+NA+SXT	1	0.56
S+C+AMP+KF+CTX+FEP+CAZ+ATM+TE+NA+SXT+E	1	0.67
S+G+C+AMP+KF+FEP+CAZ+ATM+TE+NA+SXT+E	1	0.67

* gentamicin (GEN), streptomycin (STR), amoxicillin–clavulanic-acid (AMC), ampicillin (AMP), aztreonam (ATM), cefepime (CPM), cefotaxime (CTX), ceftazidime (CAZ), ceftriaxone (CRO), cephalothin (CF), sulfamethoxazole–trimethoprim (SXT), erythromycin (E), chloramphenicol (C), ciprofloxacin (CIP), enrofloxacin (ENR), nalidixic acid (NA), doxycycline (DOX), tetracycline (TE).

** MAR (Multiple Antibiotic Resistance) Index = no. of resistance antibiotics/total number of antibiotics tested.

Multiple-Resistance to Antibiotics of *Salmonella* spp.

Table 4 reveals that 12 of the 14 isolates (85.7%) were resistant to three or more classes of antibiotics, with a majority (42.9%) resistant to five classes of antibiotics. Multiple resistance to seven classes was shown by two isolates (14.3%), while two (14.3%) were non-MDR. Of the 12 MDR isolates, 100% were resistant to the class of β-lactam antibiotics, followed by the macrolides (n = 11), phenicols (n = 10), tetracyclines (n = 10) and cotrimoxazole (n = 10). The resistance to the aminoglycosides and quinolones/fluoroquinolone were found in five isolates, respectively.

Table 4. Multiple Antibiotic Resistance Pattern of *Salmonella* spp. (n = 14) according to Antibiotic Classes

Class of Antibiotic (No. of Class)	No. of Resistant Isolate (%)
Macrolides (1)	2 (14.3%)
Phenicols, β-lactams, Macrolides (3)	1 (7.1%)
β-lactams, Tetracyclines, Quinolones/Fluoroquinolone, Macrolides (4)	1 (7.1%)
Phenicols, β-lactams, Tetracyclines, Co-trimoxazoles, Macrolides (5)	3 (21.4%)
Aminoglycosides, β-lactams, Tetracyclines, Co-trimoxazoles, Macrolides (5)	1 (7.1%)
Phenicols, β-lactams, Quinolones/Fluoroquinolone, Co-trimoxazoles, Macrolides (5)	1 (7.1%)

Table 4 (continue)

Class of Antibiotic (No. of Class)	No. of Resistant Isolate (%)
Phenicols, β-lactams, Tetracyclines, Quinolones/Fluoroquinolone, Co-trimoxazoles (5)	1 (7.1%)
Aminoglycosides, Phenicols, β-lactams, Tetracyclines, Co-trimoxazoles, Macrolides (6)	2 (14.3%)
Aminoglycosides, Phenicols, β-lactams, Tetracyclines, Quinolones/Fluoroquinolone, Co-trimoxazoles, Macrolides (7)	2 (14.3%)

Beta-lactamase Resistance Activity

ESBL activity was detected in 12 of 14 isolates (85.7%) and from Table 5, the ESBL-positive isolates showed the most frequent resistance against erythromycin (n = 11), followed by the ampicillin and aztreonam (n = 9, respectively). Resistance to trimethoprim-sulfamethoxazole, chloramphenicol and tetracycline was found in both the ESBL-producers (57.1%) and non-producers (14.3%). The isolates that were non-ESBL producers also displayed resistance to gentamicin, aztreonam (7.1%) and to ampicillin, trimethoprim-sulfamethoxazole, chloramphenicol and tetracycline (14.3%). None of the ESBL-producers and non-producers displayed resistance to three antibiotics (amoxicillin-clavulanic acid, ciprofloxacin and doxycycline).

Table 5. Extended Spectrum Beta-lactamase (ESBL)-producers and non-producers and their resistance to antibiotics (n = 14)

Class of Antibiotic	Antibiotic*	ESBL Producer (n = 12)		Non-ESBL Producer (n = 2)	
		n	%	n	%
Aminoglycosides	GEN	1	7.1%	1	7.1%
	STR	4	28.6%	0	0.0%
β-lactams	AMC	0	0.0%	0	0.0%
	AMP	9	64.3%	2	14.3%
	ATM	9	64.3%	1	7.1%
	CPM	3	21.4%	0	0.0%
	CTX	5	35.7%	0	0.0%
	CAZ	3	21.4%	0	0.0%
	CRO	2	14.3%	0	0.0%
	CF0	3	21.4%	0	0.0%
Co-trimoxazole	SXT	8	57.1%	2	14.3%
Macrolides	E	11	78.6%	2	14.3%
Phenicols	C	8	57.1%	2	14.3%

Table 5 (continue)

Class of Antibiotic	Antibiotic*	ESBL Producer (n = 12)		Non-ESBL Producer (n = 2)	
		n	%	n	%
Quinolones and fluoroquinolone	CIP	0	0.0%	0	0.0%
	ENR	1	7.1%	0	0.0%
	NA	5	35.7%	0	0.0%
Tetracyclines	DOX	0	0.0%	0	0.0%
	TE	8	57.1%	2	14.3%

* gentamicin (GEN), streptomycin (STR), amoxicillin–clavulanic-acid (AMC), ampicillin (AMP), aztreonam (ATM), cefepime (CPM), cefotaxime (CTX), ceftazidime (CAZ), ceftriaxone (CRO), cephalothin (CF), sulfamethoxazole–trimethoprim (SXT), erythromycin (E), chloramphenicol (C), ciprofloxacin (CIP), enrofloxacin (ENR), nalidixic acid (NA), doxycycline (DOX), tetracycline (TE).

DISCUSSION

The current study found a 12.7% occurrence of *Salmonella* spp. in raw chicken meat sold at retail markets in Malaysia, which is significantly lower than the 40.4% reported by Shafini *et al*. (2017) and the 30.0% reported by Thung *et al*. (2016). However, a lower prevalence of 7.5% was noted by Thung *et al*. (2018). Variations in prevalence were also observed across different Asian countries: 97.9% in Myanmar (Moe *et al*., 2017), 13.3% in China (Wang *et al*., 2021), and 12.7% in Singapore (Zwe *et al*., 2018). Compared to these figures, the prevalence of *Salmonella* in retail poultry meat in most Asian countries was higher than in the European Union (10.4%) (Gonçalves-Tenório *et al*., 2018) and the United States (U.S.) (7.67%) (Sodagari *et al*., 2024). Additionally, it was noted that the prevalence of *Salmonella* in poultry from wet markets was generally higher than in supermarket samples, with rates ranging from 25.0% to 53.9% and 12.7% to 52.3%, respectively (Tan *et al*., 2022). These findings underscore the significant role of retail chicken meats as a source of *Salmonella* spp., with variations likely attributed to differences in sampling populations, hygiene practices at retail outlets, and cross-contamination throughout the food chain.

High resistance to erythromycin observed in this study (92.9%) aligns with findings from other research conducted in Malaysia (Thung *et al*., 2016; Thung *et al*., 2018) and Nigeria (Mokgophi *et al*., 2021), where 100% resistance was reported in *Salmonella* isolated from retail chicken. The 71.4% resistance rate to chloramphenicol observed in this study was considerably higher than that reported in previous studies from Malaysia (30.4%) (Thung *et al*., 2018), Singapore (61.5%) (Zwe *et al*., 2018), Myanmar (29.7%) (Moe *et al*., 2017), Colombia (6.38%) (Cortés *et al*., 2017), and Iran (3.6%) (Sodagari *et al*., 2015). The resistance rates to trimethoprim-sulfamethoxazole among chicken isolates were relatively moderate compared to the 71.4% observed in this study, with reported rates of 70.3% in Myanmar, 61.2% in Iran and 55.8% in Singapore, as noted by Moe *et al*. (2017), Sodagari *et al*. (2015) and Zwe *et al*. (2018), respectively. Although the current study found a high resistance rate of 71.4% to tetracycline, previous research did not report any resistance to this antibiotic in *Salmonella* isolates from retail chicken meat in Malaysia (Thung *et al*., 2016; Thung *et al*., 2018). High tetracycline resistance was noted in Iran (81.0%) (Sodagari *et al*., 2015), while moderate resistance

rates were observed in Singapore (61.5%), Colombia (57.4%), Myanmar (54.3%), Italy (53.9%), and Brazil (46.2%) (Zwe *et al*., 2018; Cortés *et al*., 2017; Moe *et al*., 2017; Peruzy *et al*., 2020). In contrast, the U.S. reported a significantly lower resistance rate of 0.84% (Sodagari *et al*., 2024).

The isolates exhibited resistance to various β-lactam antibiotics, including ampicillin (78.6%), aztreonam (71.4%), and cephalosporins (cefotaxime = 35.7%, ceftazidime = 21.4%). Similar resistance patterns to ampicillin have been observed in Malaysia (72.7%) (Thung *et al*., 2016) and Singapore (78.8%) (Zwe *et al*., 2018). However, lower ampicillin resistance rates have been reported in the U.S. (2.3%) (Sodagari *et al*., 2024), Iran (11.7%) (Sodagari *et al*., 2015), Italy (44.4%) (Peruzy *et al*., 2020), Myanmar (47.1%) (Moe *et al*., 2017), and Colombia (53.19%) (Cortés *et al*., 2017). Additionally, resistance to cephalosporins was greater than that reported by Peruzy *et al*., 2020 (cefotaxime = 17.4%, ceftazidime = 6.2%) and Zhang *et al*., 2018 (cefotaxime = 9.9%, ceftazidime = 3.3%). Consistent with findings in this study, *Salmonella* isolated from retail chicken has also shown sensitivity to amoxicillin-clavulanic acid (Thung *et al*., 2018; Thung *et al*., 2016; Zhang *et al*., 2018), doxycycline (Islam *et al*., 2022), and ciprofloxacin (Sodagari *et al*., 2024; Sodagari *et al*., 2015).

This study identified a high-risk contamination source, with 85.7% of isolates exhibiting a multiple antibiotic resistance (MAR) index greater than 0.2. The MAR index of 0.67 was higher compared to some related studies in Malaysia, which reported values of 0.40 (Thung *et al*., 2016) and 0.56 (Thung *et al*., 2018). In contrast, higher index values of 0.64 and 0.81 were observed in China (Wang *et al*., 2021) and Iran (Mir *et al*., 2022), respectively. This study also demonstrated a high prevalence (85.7%) of MDR isolates, with resistance observed across five antibiotic classes: phenicols, β-lactams, tetracyclines, co-trimoxazoles, and macrolides. Recent studies in Italy (Castello *et al*., 2023), China (Wang *et al*., 2021), Iran (Sodagari *et al*., 2024), and Brazil (Pavelquesi *et al*., 2023) reported MDR rates of 80%, 75%, 62.2%, and 53.8%, respectively. Resistance has developed in common antibiotic groups used against *Salmonella*, such as aminoglycosides, β-lactams, chloramphenicol, quinolones, tetracyclines, sulfonamides, and trimethoprim (Tan *et al*., 2022). Additionally, *Salmonella* spp. in chicken is increasingly reported as multidrug-resistant worldwide (Tan *et al*., 2022). The high percentage of *Salmonella* contamination in chicken meat poses a significant risk to consumer health due to the potential for salmonellosis, and the presence of MDR strains complicates treatment.

Our results reveal a prevalence of ESBL-producing *Salmonella* at 85.7%, which is significantly higher compared to the rates reported in Japan (8.0%) and Korea (69.0%) by Taguchi *et al*. (2012) and Choi *et al*. (2015), respectively. The high prevalence of ESBL-positive *Salmonella* in retail chicken meat could restrict treatment options for severe clinical cases of *Salmonella*-related foodborne illnesses.

CONCLUSION

Our findings indicate that contamination with MDR *Salmonella* is prevalent in retail raw chicken meats, highlighting the growing importance of environmental hygiene in retail markets. The dominance of MDR strains, particularly those producing ESBL, presents a significant risk for human *Salmonella* infections. Given that chickens can be reservoirs for *Salmonella*, MDR strains may be transmitted from poultry farms to humans through the food chain, underscoring the need

for continuous surveillance and epidemiological studies on their prevalence. This calls for further research into the phenotypic and genotypic characteristics of ESBL-producing MDR *Salmonella*. Comparative genomics is essential to understand cross-contamination, horizontal gene transfer, and to develop effective strategies to mitigate *Salmonella* infections. Additionally, increasing awareness among manufacturers and consumers about proper cooking temperatures can help prevent foodborne illnesses caused by this bacterium.

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ACKNOWLEDGEMENT

This research was supported by the Faculty of Food Science and Technology, Universiti Putra Malaysia (UPM), Selangor, Malaysia under the Master of Food Safety Programme.