

Original Article

Prevalence and antimicrobial resistance of *Salmonella* serotypes isolated from retail chicken meat and giblets in Iran

Hamid Reza Sodagari¹, Zohreh Mashak², Amir Ghadimianazar²

¹Young Researchers and Elite Club, Karaj Branch, Islamic Azad University, Karaj, Iran

²Department of Food Hygiene, Karaj Branch, Islamic Azad University, Karaj, Iran

Abstract

Introduction: *Salmonella* is one of the major foodborne pathogens responsible for outbreaks of foodborne illness in humans worldwide.

Methodology: A total of 560 samples of chicken meat and giblets were collected from retail markets for *Salmonella* identification, serotyping, and antimicrobial resistance testing.

Results: *Salmonella* was detected in 19.8% of samples. Among the five serotypes identified, *S. Thompson* was the predominant type (48.7%). High antimicrobial resistance rates were observed to nalidixic acid (92.8%), tetracycline (81%), trimethoprim (68.4%), sulfamethoxazole / trimethoprim (61.2%), streptomycin (56.7%), and kanamycin (36.9%). Although resistance to chloramphenicol (3.6%), amoxicillin-clavulanic acid (5.4%), and ampicillin (11.7%) was detected, none of the isolates were resistant to ceftazidime, ceftriaxone, cefotaxime, ciprofloxacin, colistin, gentamicin, nor imipenem.

Conclusions: Restrictions on the irrational use of antibiotics in humans and animals are suggested for the reduction of resistant strains.

Key words: *Salmonella*; chicken meat and giblets; serotypes; antimicrobial resistance.

J Infect Dev Ctries 2015; 9(5):463-469. doi:10.3855/jidc.5945

(Received 23 September 2014 – Accepted 22 December 2014)

Copyright © 2015 Sodagari *et al.* This is an open-access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Introduction

Salmonella is one of the major foodborne pathogens worldwide [1,2] and is responsible for outbreaks of foodborne illness in humans via cross-contamination and consumption of undercooked meats [3,4]. It has been estimated that *Salmonella* has caused approximately one million cases of foodborne illness and 378 deaths per year in the United States [5]. *Salmonella* spp. is also the most commonly reported cause of foodborne outbreaks (39.2%) in the European Union (EU), with 2,201 outbreaks in 2007, of which 142 occurred in France [6]. High percentages (approximately 70%–80%) of foodborne bacterial outbreaks in China were caused by *Salmonella* [7]. Although other food products, such as eggs and red meats, can be contaminated with *Salmonella* spp., poultry products have been recognized to be the main source of this pathogen in humans [8]. Contamination of poultry meat can occur at different stages, including production, slaughter, processing, handling, and storage [9]. Antimicrobial agents are widely used in veterinary medicine, not only for prevention and treatment of diseases, but also as growth-promoting substances. However, the widespread use of antibiotics

promotes the development of antimicrobial-resistant bacteria, potentially worldwide [10]. The prevalence of *Salmonella* serotypes and their antimicrobial resistance in chicken meat and giblets have been reported in many investigations around the world [11–20]. Despite considerable progress in human public health, *Salmonella* still remains a significant foodborne pathogen in the food chain. Based on the importance of this pathogen in human public health, this study was carried out to determine the prevalence and antimicrobial resistance of *Salmonella* strains isolated from retail chicken meat and giblets in Alborz Province, Iran.

Methodology

A total of 560 samples of retail chicken meat (200) and giblets, which included liver (120), gizzard (120), and heart (120), were purchased from retail markets in Alborz Province between October 2013 and March 2014. All samples were transferred under cold conditions (using icepacks) to the laboratory for microbial examination. For *Salmonella* identification, 25g of each meat sample was homogenized for 2 minutes with 225 mL of buffered peptone water

(Merck, Darmstadt, Germany) and then incubated for 24 hours at 37°C. After incubation, 0.1 mL of the broth was transferred into 10 mL of selenite cystine broth (Merck) and incubated at 42°C for 24 hours. The enrichment samples were then subcultured on to *Salmonella*-*Shigella* agar and brilliant green agar (both Merck) and incubated for 24 hours at 37°C. Presumptive *Salmonella* isolates were identified by using triple sugar iron agar, lysine iron agar, and urea agar (all Merck) at 37°C.

Serotyping

Salmonella isolates were further serotyped by direct agglutination method using antisera against O and H antigens (BioRad, Marnes-la-Coquette, France) and the Kauffman-White classification schema [21].

Antimicrobial susceptibility test

The antimicrobial susceptibility of *Salmonella* isolates was determined by the disk diffusion method on Mueller-Hinton agar (Britania, Buenos Aires, Argentina), performed according to the Clinical and Laboratory Standards Institute guidelines [22]. The following antibiotics were used: amoxicillin-clavulanic-acid (30µg), ampicillin (10µg), ceftazidime (30µg), ceftriaxone (30µg), cefotaxime (30µg), chloramphenicol (30µg), ciprofloxacin (5µg), colistin (10µg), gentamicin (10µg), kanamycin (30µg), imipenem (10µg), nalidixic acid (30µg), streptomycin (10µg), sulfamethoxazole / trimethoprim (1.25/23.75 µg), tetracycline (30µg), and trimethoprim (5µg). After incubation at 35°C for 24 hours, the zone of inhibition around each disk was measured and evaluated according to the Clinical and Laboratory Standards Institute guidelines [22]. *Escherichia coli* ATCC25922 was used as a quality control strain.

Results and Discussion

Of 560 examined samples, 111 (19.8%) were contaminated with *Salmonella* spp. Table 1 shows the prevalence of *Salmonella* spp. isolated from examined samples. The incidence of *Salmonella* spp. in chicken products obtained by other authors varied between 0 and 100% [23,24]. In this study, the overall prevalence of *Salmonella* in chicken meat and giblets was 19.8% (111/560). The contamination rate of chicken meat samples (29%) is in agreement with results reported in Belgium [25], the United Kingdom [26], Iran [27], China [28], Turkey [29], Iraq [30], and the Russian Federation [31], but lower than results found in Iran [20,32] and many other countries, such as China, Mexico, and Poland [16,18,33-35]. The

incidence of *Salmonella* spp. was found to be 21.6% in chicken liver samples, 14.1% in heart samples, and 8.3% in gizzard samples. In a previous study in Iran, the incidence of *Salmonella* spp. contamination in chicken liver, heart, and gizzard was found to be 18%, 6%, and 4%, respectively [36], which was lower than that found in the present study. However, contamination levels higher than those in this study were reported from Egypt and Ethiopia at incidence rates of 40% and 48%, respectively, in chicken livers, and 34.5% and 23.7%, respectively, in chicken hearts [37,11]. The reasons for the higher incidence of *Salmonella* contamination in chicken meat than in giblets in the present study can be due to the defeathering process, which may spread microorganisms between carcasses [37]. All previous studies showed that *Salmonella* was widely distributed in retail meat globally, which increased salmonellosis following consumption of contaminated meat or cross-contamination in households. This risk may be higher if chicken meat or giblets are consumed undercooked [38,25]. Data on the prevalence of *Salmonella* in different studies were difficult to compare because the observed prevalence may be biased by diversity in sampling methods, sampling seasons, and techniques [28]. However, variations observed between the reported *Salmonella* prevalence in previous investigations around the world may be due to several factors, including the initial salmonellosis in live birds, sanitation within the slaughterhouse, possible contamination during poultry processing steps (e.g., the amount of cross-contamination of chicken carcasses by contact with intestinal tracts during slaughter or processing), and differences among isolation methods applied to detect *Salmonella* [36]. Among the 111 positive isolates found in the present study, five different serotypes (*S. Thompson*, *S. Enteritidis*, *S. Typhimurium*, *S. Newport*, and *S. Hadar*) were completely identified in 107 samples. *S. Thompson* (48.7%) was the serotype most frequently detected, followed by *S. Enteritidis* (22.5%), *S. Typhimurium* (12.6%), *S. Newport* (7.2%), and *S. Hadar* (5.4%). Four isolates (3.6%) were not completely serotyped (Table 2). *S. Thompson* was the predominant serotype in uncooked chicken and beef in Tehran. It is one of the most important *Salmonella* serotypes that can cause outbreaks and infection in poultry [32]. In the United States, the Centers for Disease Control and Prevention (CDC) has reported that *S. Enteritidis*, *S. Typhimurium*, and *S. Newport* are the most prevalent serotypes reported by public health laboratories [39].

Table 1. Prevalence of *Salmonella* isolated from chicken meat and giblets

Sample type	Number of samples		
	Examined	Positive	%
Chicken meat	200	58	29
Liver	120	26	21.6
Heart	120	17	14.1
Gizzard	120	10	8.3
Total	560	111	19.8

Table 2. Distribution of *Salmonella* serotypes in chicken meat and giblets

Serotype	Number of positive samples				
	Chicken meat	Liver	Heart	Gizzard	Total
<i>S. Thompson</i>	35 (31.6%)	8 (7.2%)	6 (5.4%)	5 (4.5%)	54 (48.7%)
<i>S. Enteritidis</i>	12 (10.8%)	7 (6.3%)	4 (3.6%)	2 (1.8%)	25 (22.5%)
<i>S. Typhimurium</i>	3 (2.7%)	7 (6.3%)	2 (1.8%)	2 (1.8%)	14 (12.6%)
<i>S. Newport</i>	0 (0.0%)	3 (2.7%)	5 (4.5%)	0 (0.0%)	8 (7.2%)
<i>S. Hadar</i>	6 (5.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (5.4%)
NCS*	2 (1.8%)	1 (0.9%)	0 (0.0%)	1 (0.9%)	4 (3.6%)
Total	58 (52.3%)	26 (23.4%)	17 (15.3%)	10 (9%)	111 (100%)

*Not completely serotyped

Table 3. Prevalence of antimicrobial resistance of *Salmonella* serotypes isolated from retail chicken meat and giblets

Serotypes	No. of isolates	Antimicrobials n (%)															
		AMC	AMP	CTZ	CRO	CTX	CHL	CIP	COL	GEN	IMI	KAN	NAL	STR	SXT	TET	TMP
<i>S. Thompson</i>	54	3 (5.5)	7 (12.9)	0 (0)	0 (0)	0 (0)	2 (3.7)	0 (0)	0 (0)	0 (0)	0 (0)	17 (31.5)	52 (94.4)	32 (59.2)	39 (72.2)	49 (90.7)	41 (75.9)
<i>S. Enteritidis</i>	25	0 (0)	2 (8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	11 (44)	22 (88)	14 (56)	13 (52)	12 (48)	17 (68)
<i>S. Typhimurium</i>	14	0 (0)	2 (14.2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	5 (35.7)	12 (85.7)	8 (57.1)	9 (64.2)	12 (85.7)	11 (78.5)
<i>S. Newport</i>	8	2 (25)	1 (12.5)	0 (0)	0 (0)	0 (0)	1 (12.5)	0 (0)	0 (0)	0 (0)	0 (0)	3 (37.5)	7 (87.5)	4 (50)	0 (0)	8 (100)	1 (12.5)
<i>S. Hadar</i>	6	0 (0)	1 (16.6)	0 (0)	0 (0)	0 (0)	1 (16.6)	0 (0)	0 (0)	0 (0)	0 (0)	4 (66.7)	6 (100)	3 (50)	5 (83.3)	6 (100)	4 (66.6)
NCS	4	1 (25)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (25)	4 (100)	2 (50)	2 (50)	3 (75)	2 (50)
Total	111	6 (5.4)	13 (11.7)	0 (0)	0 (0)	0 (0)	4 (3.6)	0 (0)	0 (0)	0 (0)	0 (0)	41 (36.9)	103 (92.8)	63 (56.7)	68 (61.2)	90 (81)	76 (68.4)

AMC: amoxicillin-clavulanic acid; AMP: ampicillin; CTZ: ceftazidime; CRO: ceftriaxone; CTX: cephalexin; CHL: chloramphenicol; CIP: ciprofloxacin; COL: colistin; GEN: gentamicin; IMI: imipenem; KAN: kanamycin; NAL: nalidixic acid; STR: streptomycin; SXT: sulfamethoxazole/trimethoprim; TET: tetracycline; TMP: trimethoprim; NC: not completely serotyped

All these serotypes are common isolates from chicken meat. *Salmonella* serotypes detected in this study are in agreement with CDC report. Previous studies have reported some of the serotypes that were identified in this study [13,14,16,20,32,36]. This distribution of *Salmonella* serotypes could vary from country to country. Among the *Salmonella* serotypes, *S. Enteritidis* and *S. Typhimurium* are the predominant serotypes found in human salmonellosis in many developed countries, including Japan, Australia, New

Zealand, and many countries in Europe [40]. There are reports of human salmonellosis caused by consumption of poultry meat contaminated by *S. Typhimurium* [41]. Although *S. Typhimurium* is the most common agent of human foodborne disease, in the last few decades, *S. Enteritidis* has become more common [42].

The increase in the prevalence of resistant microorganisms is an important problem for the treatment and prevention of infectious diseases in both

Table 4. Multiple antimicrobial resistance patterns of *Salmonella* serotypes isolated from chicken meat and giblets

Serotype	Antibiotic resistance profile (resistance to two or more)	Number of multi-resistant isolates
<i>S. Thompson</i>	NAL, TET, TMP, SXT, STR, KAN, AMP	1
	NAL, TET, TMP, SXT, STR, KAN	3
	NAL, TET, TMP, SXT, STR, AMC	1
	NAL, TET, STR, KAN, TMP	5
	NAL, TET, STR, KAN, SXT	2
	NAL, TET, STR, CIP	1
	NAL, TET, TMP	3
	NAL, TET, SXT	1
	NAL, TET	4
	TET, STR	2
	TET, TMP	3
<i>S. Enteritidis</i>	NAL, TET, TMP, SXT, STR	2
	NAL, TET, STR, KAN	1
	NAL, TET, TMP, SXT	3
	NAL, TET, STR, KAN	2
	NAL, TET, STR	3
	NAL, TET, AMP	1
	NAL, TMP	4
	NAL, AMP	1
<i>S. Typhimurium</i>	NAL, TET, TMP, SXT	2
	NAL, TET, TMP, STR	1
	NAL, TET, SXT, KAN	1
	NAL, TET, TMP	1
	NAL, TET, KAN	1
	TET, TMP, AMP	1
	NAL, TET, AMP	1
<i>S. Newport</i>	NAL, TET, STR, KAN	2
	NAL, TET, STR, TMP	1
	NAL, TET, STR	1
	NAL, TET, KAN, CHL	1
	NAL, TET, AMC	2
	TET, AMP	1
<i>S. Hadar</i>	NAL, TET, TMP, SXT, STR, KAN	3
	NAL, TET, TMP, SXT	1
	NAL, TET, KAN, AMP	1
	NAL, TET, SXT, CHL	1
NCS	NAL, TET, TMP, SXT, KAN	1
	NAL, TET, TMP, STR	1
	NAL, TET, AMC	1
	NAL, STR, SXT	1

AMC: amoxicillin-clavulanic acid; AMP: ampicillin; CTZ: ceftazidime; CRO: ceftriaxone; CTX: cephalexin; CHL: chloramphenicol; CIP: ciprofloxacin; COL: colistin; GEN: gentamicin; IMI: imipenem; KAN: kanamycin; NAL: nalidixic acid; STR: streptomycin; SXT: sulfamethoxazole/trimethoprim; TET: tetracycline; TMP: trimethoprim; NC: not completely serotyped

humans and animals [2]. Antimicrobial resistance in *Salmonella* serotypes has been a global problem, with rates increasing from between 20% and 30% in the early 1990s to as high as 70% in some countries at the turn of the century [43,44]. The results of antimicrobial resistance tests of 111 *Salmonella* isolates to 16 antimicrobials are shown in Table 3.

In this study, high antimicrobial resistance rates were found against nalidixic acid (92.8%), tetracycline (81%), trimethoprim (68.4%), sulfamethoxazole / trimethoprim (61.2%), streptomycin (56.7%), and kanamycin (36.9%). As in the present study, resistance to the above antibiotics have also been frequently reported in a number of other investigations on poultry products in Iran and other countries [12,18-20,28,32,36,45-48]. The *Salmonella* resistance rates to nalidixic acid (92.8%) and tetracycline (81%) found in this study were higher than resistance rates to other antimicrobials because of the overuse of these antimicrobials for treatment and growth promotion in different fields. These findings are comparable with those reported in Iran (nalidixic acid, 90.6%; tetracycline, 71.6%) [20], but higher than those reported in Turkey (nalidixic acid, 62.5%; tetracycline, 6.2%) [13] and China (nalidixic acid, 47%; tetracycline, 50%) [28]. Also, low antimicrobial resistance rates were observed in the present study to chloramphenicol (3.6%), amoxicillin-clavulanic acid (5.4%), and ampicillin (11.7%); these rates were slightly higher than those found by Soltan Dallal *et al.* [32]. Although a few *Salmonella* isolates showed resistance to chloramphenicol, amoxicillin-clavulanic acid, and ampicillin, the isolates were still largely susceptible to these antimicrobials. Luckily, no isolates were identified that were resistant to ceftazidime, ceftriaxone, cephalexin, ciprofloxacin, colistin, gentamicin, and imipenem. This may be explained by the limited availability and high cost of these antimicrobials, which would decrease their frequent utilization in veterinary or public health practices in Iran. These antimicrobials can be used effectively to treat *Salmonella* infections. Despite increasing resistance to commonly used antibiotics in animal and human medicine globally, the numbers of multidrug-resistant *Salmonella* isolates continues to increase [2,11]. The percentage of multidrug-resistant *Salmonella* strains observed in this study (62.2%) is higher than that reported in Italy (2.3%) [49] and Iran (23.5%) [20], although lower than that found in Morocco (75.43%) [17], Portugal (75%) [50], Turkey (100%) [13,16,29], Spain (100%) [2], Brazil (100%) [51], Nepal (100%) [52], the United States (92%) [53],

Mexico (85.4%) [34], and China (80%) [54]. In the present study, all *S. Hadar* isolates showed multidrug resistance to nalidixic acid and tetracycline (Table 4).

These findings confirm that in Iran, poultry is a major reservoir of multidrug-resistant *Salmonella*, and suggest that it is difficult to achieve successful antimicrobial therapy for human salmonellosis caused by strains of poultry origin. Resistance to two or more antibiotics was found in 26 isolates of *S. Thompson*, followed by 17, 8, 8, 6, and 4 isolates of *S. Enteritidis*, *S. Typhimurium*, *S. Newport*, *S. Hadar*, and not completely serotyped serotypes, respectively (Table 4). The high prevalence of antimicrobial resistance identified in the present study can be explained by the widespread use of common antimicrobials as prophylactics, growth promoter agents, or in veterinary medicine. Furthermore, unlimited access to these agents without a prescription as well as low rates of antibiotic sensitivity tests for the selection of suitable drugs in Iran may be additional reasons for the high level of resistance.

Conclusions

The results of this study suggest that improving sanitation in poultry slaughterhouses could decrease *Salmonella* contamination and, as a result, human disease. Increasingly antibiotic-resistant strains constitute a public health hazard through transmission of these strains to humans via food products. Therefore, conducting antibiotic sensitivity tests and establishing a regular monitoring system for identification of resistance prevalence in food is necessary to reduce the spread of resistant strains.

References

1. Soutose N, Koidis P, Madden, RH (2003) Prevalence of *Listeria* and *Salmonella* in retail chicken in Northern Ireland. J Appl Microbiol 37: 421-423.
2. Carraminana JJ, Rota C, Agustin I, Herrera A (2004) High prevalence of multiple resistance to antibiotics in *Salmonellae* serovars isolated from a poultry slaughterhouse in Spain. Vet Microbiol 104: 133-139.
3. Bailey JS, Cosby DE (2003) Detection of *Salmonellae* from chicken rinses and chicken hot dogs with automated Bax PCR system. J Food Protect 66: 2138-2140.
4. Kimura AC, Reddy V, Marcus R (2004) Chicken consumption is a newly identified risk factor for sporadic *Salmonellae* enteric serotype *enteritidis* infections in the United States. Clin Infect Dis 38: 244-252.
5. Scallan E, Hoekstra RM, Angulo FJ, Tauxe RV, Widdowson MA, Roy SL (2011) Foodborne illness acquired in the United States major pathogens. Emerg Infect Dis 17: 7-15.
6. European Food Safety Authority (2009) The community summary report on food-borne outbreaks in the European Union in 2007. Available:

- <http://www.efsa.europa.eu/en/efsajournal/doc/271r.pdf>. Accessed: August 2014
7. Wang J, Zheng RZ, Wang JY (2007) Risk assessment of *Salmonella* in animal derived food. Clin J Animal Quarantine 24: 23-25.
 8. Snoeyenbos GH, Williams JE (1991) *Salmonellosis*. In Calnek BW, editor. Diseases of Poultry, 9th ed. Iowa: Iowa State University Press. Ames 72-73.
 9. Dookeran MM, Baccus-Taylor GS, Akingbala JO, Tameru B, Lammerding AM (2012) Transmission of *Salmonella* on broiler chickens and carcasses from production to retail in Trinidad and Tobago. J Agricult Biodiver Res 1: 78-84.
 10. Aminov RI (2010) A brief history of the antibiotic era: lessons learned and challenges for the future. Front Microbiol 1: 134.
 11. Molla B, Mesfin A, Alemayehu D (2003) Multiple antimicrobial-resistant *Salmonella* serotypes isolated from chicken carcass and giblets in Debre Zeit and Addis Ababa, Ethiopia. Ethiopian J Health Develop 17: 131-149.
 12. Bada-Alamedji R, Fofana A, Seydi M, Akakpo AJ (2006) Antimicrobial resistance of *Salmonella* isolated from poultry carcasses in Dakar (Senegal). Brazil J Microbiol 37: 510-515.
 13. Kasimoglu Dogru A, Ayaz ND, Gencay YE (2010) Serotype identification and anti-microbial resistance profiles of *Salmonella* spp. isolated from chicken carcasses. Tropical Animal Health and Production 42(5): 893-897.
 14. Álvarez-Fernández E, Alonso-Calleja C, García-Fernández C, Capita R (2012) Prevalence and antimicrobial resistance of *Salmonella* serotypes isolated from poultry in Spain: Comparison between 1993 and 2006. Int J Food Microbiol 153: 281-287.
 15. Wang H, Ye K, Wei X, Cao J, Xu X, Zhou G (2013) Occurrence, antimicrobial resistance and biofilm formation of *Salmonella* isolates from a chicken slaughter plant in China. Food Control 33: 378-384.
 16. Yildirim Y, Gonulalan Z, Pamuk S, Ertas N (2011) Incidence and antibiotic resistance of *Salmonella* spp. on raw chicken carcasses. Food Res Int 44: 725-728.
 17. Abdellah C, Fouzia RF, Abdelkader C, Rachida SB, Mouloud Z (2009) Prevalence and anti-microbial susceptibility of *Salmonella* isolates from chicken carcasses and giblets in Meknès, Morocco. African J Microbiol Res 3: 215-219.
 18. Maka L, Mackiw EM, Sciezynska H, Pawlowska K (2014) Antimicrobial susceptibility of *Salmonella* strains isolated from retail meat products in Poland between 2008 and 2012. Food Control 36: 199-204.
 19. Berrang ME, Ladely SR, Simmons M, Fletcher DL, Fedorka-Cray PJ (2006) Antimicrobial resistance patterns of *Salmonella* from retail chicken. Int J Poultry Sci 5: 351-354.
 20. Soltan Dallal MM, Taremi M, Gachkar L, Modarressi S, Sanaei M, Bakhtiari R, Sharifi Yazdi MK, Zali MR (2009) Characterization of antibiotic resistant patterns of *Salmonella* serotypes isolated from beef and chicken samples in Tehran. Jundishapur J Microbiol 2: 124- 131.
 21. Brenner FW (1998) Modified Kaufmann–White Scheme. Centers for disease control and prevention, Atlanta, Ga. pp. 459-474
 22. Clinical and Laboratory Standards Institute (2006) Performance standards for antimicrobial susceptibility testing: 16th informational supplement. M100-S16 26(3). Wayne, PA: CLSI.
 23. Bryan FL, Doyle MP (1995) Health risk and consequence of *Salmonella* and *Campylobacter jejuni* in raw poultry. J Food Protect 58:326-344.
 24. Foley SL, Lynne AM, Nayak R (2008) *Salmonella* challenges: prevalence in swine and poultry and potential pathogenicity of such isolates. J Animal Sci 86: E149–E162.
 25. Uyttendaele MR, Debevere JM, Lips RM, Neyts KD (1998) Prevalence of *Salmonella* in poultry carcasses and their products in Belgium. Int J Food Microbiol 40: 1-8.
 26. Plummer RAS, Blissett SJ, Dodd CR (1995) *Salmonella* contamination of retail chicken products sold in the UK. J Food Protect 58: 843-846.
 27. Mehrabian S, Jaber E (2007) Isolation, Identification and Antimicrobial resistance patterns of *Salmonella* from meat products in Tehran. Pak J Biol Sci 10: 122-126.
 28. Li R, Lai J, Wang Y, Liu S, Li Y, Liu K, Shen J, Wu C (2013) Prevalence and characterization of *Salmonella* species isolated from pigs, ducks and chickens in Sichuan Province, China. Int J Food Microbiol 163: 14-18.
 29. Arslan S, Eyi A (2010) Occurrence and antimicrobial resistance profiles of *Salmonella* species in retail meat products. J Food Protect 73: 1613-1617.
 30. Dhaheer FH, Awani MN, Mahmood MM, Jamil HS (2011) Isolation and diagnosis of *Salmonella* in animal origin food, import feed in Baghdad local markets and local poultry farms. Iraq Journal Market Res Consumer Protect 3: 1-19.
 31. Alali WQ, Gaydashov R, Petrova E, Panin A, Tugarinov O, Kulikovskii A (2012) Prevalence of *Salmonella* on retail chicken meat in Russian Federation. J Food Protect 75: 1469-1473.
 32. Soltan Dallal MM, Doyle MP, Rezadehbashi M, Dabiri H, Sanaei M, Modarressi S, Bakhtiari R, Sharifiy K, Taremi M, Zali MR, Sharifi-Yazdi MK (2010) Prevalence and antimicrobial resistance profiles of *Salmonella* serotypes, *Campylobacter* and *Yersinia* spp. isolated from retail chicken and beef, Tehran, Iran. Food Control 21: 388-392.
 33. Cui HX, Zhang XL, Liao XG, Zhang D, Hu D, Zhang M, Zhang GW (2009) Monitoring and analysis for food-borne pathogens in Henan in 2007. Chinese J Health Lab Tech 19: 173-175.
 34. Miranda JM, Mondragon AC, Martinez B, Guarddon M, Rodriguez JA (2009) Prevalence and antimicrobial resistance patterns of *Salmonella* from different raw foods in Mexico. J Food Protect 72: 966-971.
 35. Zhu J, Wang Y, Song X, Cui S, Xu H, Yang B, Huang J, Liu G, Chen Q, Zhou G, Chen Q, Li F (2014) Prevalence and quantification of *Salmonella* contamination in raw chicken carcasses at the retail in China. Food Control 44: 198-202.
 36. Rahimi E (2012) Prevalence and antimicrobial resistance of *Salmonella* spp isolated from retail chicken, turkey and ostrich by-products in Iran. Revue de MédecineVétérinaire 163: 271-275.
 37. Abd el-Aziz DM (2013) Detection of *Salmonella typhimurium* in retail chicken meat and chicken giblets. Asia P J Trop Biomed 3:678-681.
 38. Scott E (1996) Foodborne diseases and other hygiene issues in the home. J Appl Bacteriol 80: 5-9.
 39. Centers for Disease Control and Prevention (2009) Preliminary Food Net Data on the incidence of infection with pathogens transmitted commonly through food—10 states, 2008. MMWR 58: 333-337. Available: <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5813a2.htm?>. Accessed: August 2014

40. Fisher IS (2004) Dramatic shift in the epidemiology of *Salmonella enterica* serotype *Enteritidis* phage types in western Europe, 1998-2003: results from the Enter-net international *Salmonella* database. *EuroSurveill* 9: 43-45.
41. Jackson BR, Griffin PM, Cole D, Walsh KA, Chai SJ (2013) Outbreak-associated *Salmonella enterica* Serotypes and Food Commodities, United States, 1998–2008. *Emerg Infect Dis* 19: 1239–1244.
42. Freitas OC, Penha Filho RAC, Barrow P, Berchieri Junior A (2010) Sources of human non typhoid *salmonellosis*: a review. *Brazil J Poultry Sci* 12: 1-11.
43. Lee HY, Su LH, Tsai MH, Kin SW, Chang HH, Jung SL (2009) High rate of reduced susceptibility to ciprofloxacin and ceftriaxone among non typhoid *Salmonella* clinical isolates in Asia. *Antimicrob Agents Chemother* 53: 2696-2699.
44. Su LH, Chiu CH, Chu CS, Ou JT (2004) Antimicrobial resistance in non typhoid *Salmonella* serotypes: a global challenge. *Clin Infect Dis* 39: 546-551.
45. Fallah SH, Asgharpour F, Naderian Z, Moulana Z (2013) Isolation and determination of antibiotic resistance patterns in non typhoid *Salmonella spp* isolated from chicken. *Int J Enter Pathog* 1: 17-21.
46. Zdragas A, Mazaraki K, Vafeas G, Giantzi V, Papadopoulos T, Ekateriniadou L (2012) Prevalence, seasonal occurrence and antimicrobial resistance of *Salmonella* in poultry retail products in Greece. *Lett Appl Microbiol* 55: 308-313.
47. Bhatia LCJ, Mathur CA, Arora CM (2007) Reemergence of chloramphenicol sensitivity in enteric fever. *Med J Armed Forces India* 63: 212-214.
48. Mayrhofer S, Paulsen P, Smulders FJM, Friederike H (2004) Antimicrobial resistance profile of five major foodborne pathogens isolated from beef, pork and poultry. *Int J Food Microbiol* 97: 23-29.
49. Nastasi A, Mammina C, Cannova L (2000) Antimicrobial resistance in *Salmonella enteritidis*, southern Italy, 1990 – 1998. *Emerg Infect Dis* 6: 401-403.
50. Antunes P, Reu C, Sousa JC, Peixe L, Pestana N (2003) Incidence of *Salmonella* from poultry products and their susceptibility to antimicrobial agents. *Int J Food Microbiol* 82:97-103.
51. Dias de Oliveira S, Siqueira Flores F, Ruschel dos Santos L, Brandelli A (2005) Antimicrobial resistance in *Salmonella enteritidis* strains isolated from broiler carcasses, food, human and poultry-related samples. *Int J Food Microbiol* 97: 297-305.
52. Shrestha A, Regmi P, Dutta RK, Khanal DR, Aryal SR, Thakur RP, Karki D, Singh UM (2010) First report on antimicrobial resistance of *Salmonella* isolated from poultry in Nepal. *Vet Microbiol* 144: 522-524.
53. Zhao S, Fedorka-Cray PJ, Friedman S, McDermott PF, Walker RD, Qaiyumi S, Foley S.L, Hubert, SK, Ayers S, English L, Dargatz DA, Salamone B, White DG (2005) Characterization of *Salmonella typhimurium* of animal origin obtained from the national antimicrobial resistance monitoring system. *Foodborne Pathog Dis* 2: 169-181.
54. Yang B, Qu D, Zhang X, Shen J, Cui S, Shi Y, Xi M, Sheng M, Zhi S, Meng J (2010) Prevalence and characterization of *Salmonella* serovars in retail meats of market place in Shaanxi, China. *Int J Food Microbiol* 141: 63-72.

Corresponding author

Zohreh Mashak
 Department of Food Hygiene
 Karaj Branch, Islamic Azad University
 Karaj, PO 31485-313, Iran
 Phone: +98 9123612387
 Email: zohremashak@gmail.com

Conflict of interests: No conflict of interests is declared.

Copyright of Journal of Infection in Developing Countries is the property of Journal of Infection in Developing Countries and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.