Prevalence and antimicrobial resistance of *Listeria, Salmonella*, and *Yersinia* species isolates in ducks and geese

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ABSTRACT The aims of this study were to determine the prevalence and antimicrobial resistance of *Listeria, Salmonella*, and *Yersinia* spp. isolated from duck and goose intestinal contents. A total of 471 samples, including 291 duck and 180 goose intestinal contents, were purchased from wet markets between November 2008 and July 2010. *Listeria*, *Salmonella*, and *Yersinia* spp. were isolated from 58 (12.3%), 107 (22.7%), and 80 (17%) of the samples, respectively. It was concluded that *Listeria ivanovii*, *Salmonella* Thompson, and *Yersinia enterocolitica* were the predominant serovars among *Listeria*, *Salmonella*, and *Yersinia* spp., respectively. Moreover, resistance to tetracycline was common in *Listeria* (48.3%) and *Salmonella* spp. (63.6%), whereas 51.3% of the *Yersinia* spp. isolates were resistant to cephalothin. Therefore, continued surveillance of the prevalence of the pathogens and also of emerging antibiotic resistance is needed to render possible the recognition of foods that may represent risks and also ensure the effective treatment of listeriosis, salmonellosis, and yersiniosis.

Key words: *Listeria* spp., *Salmonella* spp., *Yersinia* spp., duck, goose

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INTRODUCTION

The public health concern of microbiological food safety is increasing worldwide. *Listeria*, *Salmonella*, and *Yersinia* spp. that cause foodborne diseases are the common significant pathogens in terms of food safety and present a public health risk for consumers, especially in developing countries (Soltan-Dallal et al., 2010; Adzitey et al., 2012; Jamali et al., 2013). Some studies have reported that animal origin foods are considered as vehicles related with infections caused by *Listeria*, *Salmonella*, and *Yersinia* spp. (Cretikos et al., 2008; Jamali et al., 2013).

Human antimicrobial treatment for listeriosis, salmonellosis, and yersiniosis in most cases is not indicated. Although, antibiotic therapy is necessary in some critical cases such as infections of immune-compromised persons and extraintestinal disease, where antimicrobial resistance of the pathogens could complicate the treatment (Engberg et al., 2004). The use of antimicrobials in animal foods for the growth promotion, control, or treatment of poultry diseases has been increased. However, the overuse of these antibiotics may increase the rates of antimicrobial resistance to several antibiotics (Castanon, 2007; Mathew et al., 2007). The growing problem of antimicrobial resistance among poultry-associated pathogens may represent a risk of human infections with these organisms.

To the best of our knowledge, there is no published information regarding antibiotic susceptibility of *Listeria*, *Salmonella*, and *Yersinia* spp. from ducks and geese in Iran. The aim of this study was to investigate the prevalence and antimicrobial resistance profiles of these foodborne pathogens isolated from duck and goose intestinal contents in Varamin, Tehran province, Iran.

MATERIALS AND METHODS

Sample Collection

A total of 471 samples, including intestinal contents of ducks (n = 291) and geese (n = 180), were randomly collected from different wet markets located in Varamin, Tehran province, Iran, between November 2008 and July 2010. The samples were transferred into sterile plastic bags and transported in an ice box to the laboratory within 3 h and analyzed immediately.

Isolation and Identification of Isolates

Listeria spp. In this study, the isolation and detection of *Listeria* spp. was done by the USDA method

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(McClain and Lee, 1988). Briefly, 25 g of each sample was added to 225 mL of *Listeria* enrichment broth (Oxoid, Basingstoke, UK) as first enrichment broth, mixed for 2 min, and incubated at 37°C for 24 h. Then, 1 mL of *Listeria* enrichment broth was added to 9 mL of Fraser broth (Oxoid) as a second enrichment culture and incubated for 24 h at 37°C. Then, enriched Fraser broth-culture was streaked onto Palcam agar (Oxoid) and Oxford agar (Oxoid) and incubated at 37°C for 24 to 48 h. Presumptive *Listeria* colonies were confirmed by using the biochemical tests (Aygun and Pehlivanlar, 2006) and API *Listeria* (bioMérieux).

Salmonella spp. The standard conventional culture method was used in the isolation of *Salmonella* spp. in this study as described by Varnam and Evans (1991). Briefly, 25 g of each sample was added to 225 mL of buffered peptone water (Merck, Darmstadt, Germany), mixed for 2 min and incubated for 24 h at 37°C. Then, 0.1 mL of the broth was added to 10 mL of selenite cystine broth (Merck) and was incubated at 42°C overnight. Finally, enriched selenite cystine broth-culture was streaked onto *Salmonella Shigella* agar (Merck) and brilliant green agar (Merck). All plates were then incubated at 37°C for overnight. Presumptive *Salmonella* colonies were confirmed by using API 20E (bioMérieux 20100, Marcy l'Etoile, France). *Salmonella* polyvalent O and H antisera (Mast Diagnostics, Merseyside, UK) were used for agglutination tests.

Yersinia spp. Twenty-five gram of each sample was added to 225 mL of PBS. The samples were mixed for 2 min and incubated for 3 wk at 4°C. Then, the cold-enriched samples were subjected to alkali treatment by adding 0.5 mL of 0.5% KOH into 4.5 mL of cold-enriched samples. The cold-enriched and alkali-treated cultures were streaked onto cefsulodin-Irgasan-novobiocin agar and incubated for 18 to 24 h at 25°C. Presumptive *Yersinia* colonies were confirmed by using the API 20E (bioMérieux 20100).

Antimicrobial Susceptibility Test

All *Listeria*, *Salmonella*, and *Yersinia* spp. were subjected to antimicrobial susceptibility tests. The Kirby-Bauer disc diffusion method using Mueller Hinton agar (Oxoid) was applied to antimicrobial susceptibility test according to the Clinical and Laboratory Standards Institute (CLSI, 2006). However, Muller-Hinton agar supplemented with 5% defibrinated sheep blood was used for *Listeria* spp. The following panel of antimicrobial agents and concentrations was applied: tetracycline (30 μg), gentamicin (10 μg), chloramphenicol (30 μg), trimethoprim (15 μg), ampicillin (30 μg), amoxicillin (30 μg; for all isolates); vancomycin (30 μg), rifampicin (5 μg), penicillin G (10 unit), kanamycin (30 μg), erythromycin (15 μg), clindamycin (2 μg), amoxicillin-clavulanic acid (20/10 μg; for *Listeria spp.*), streptomycin (30 μg), nalidixic acid (30 μg), ciprofloxacin (5 μg), cephalothin (30 μg; for *Yersinia* spp.), and streptomycin (30 μg), nalidixic acid (30 μg), ciprofloxacin (5 μg), and colisitin (10 μg; for *Salmonella* spp.).

Statistical Analysis

The relationship between the contaminated samples and the different kinds of samples was analyzed using chi-squared analysis. All statistical and chi-squared analyses were performed using SPSS 18.0 (SPSS Inc., Chicago, IL). A P-value < 0.05 was used for statistical significance.

RESULTS

The obtained results showed that 58 (12.3%), 107 (22.7%), and 80 (17%) of duck and goose intestinal contents samples were contaminated with *Listeria*, *Salmonella*, and *Yersinia* spp., respectively.

Listeria spp.

Prevalence of Listeria spp. in Ducks and Geese. In this study, 58 (12.3%) samples were contaminated with *Listeria* spp., and among them, 41 (14.1%) and 17 (9.4%) duck and goose samples were contaminated with *Listeria* spp., respectively (Table 1). There was a significant difference between contaminated duck samples and goose samples ($P < 0.05$). The highest prevalence of *Listeria* spp. was *Listeria ivanovii* (43.1%) followed by *Listeria monocytogenes* (32.8%), *Listeria innocua* (8.6%), and *Listeria seeligeri* (15.5%).

Antimicrobial Resistance of Listeria spp. Isolates. The resistance profiles of *Listeria* spp. to 10 antimicrobial agents tested in this study are shown in Table 2. Thirty-two (55.2%) and 8 (13.8%) out of 58 isolates of *Listeria* spp. were resistant to 1 and 2 antibiotic agents, respectively. However, 3 *Listeria* spp. isolates (5.2%) showed multidrug resistance (**MDR**; resistance to >2 antimicrobial). Resistance to tetracycline (48.3%) was the most common finding in this study, followed by resistance to penicillin G (24.1%), erythromycin (12.1%), clindamycin (10.3%), and amox-

Table 1. Prevalence (% in parentheses) of *Listeria* spp. in duck and goose samples

Samples	Total	*Listeria* spp.	*Listeria monocytogenes*	*Listeria ivanovii*	*Listeria innocua*	*Listeria seeligeri*
Duck	291	41 (14.1)	14 (4.8)	16 (5.5)	4 (1.4)	7 (2.4)
Goose	180	17 (9.4)	5 (2.8)	9 (5)	1 (0.6)	2 (1.1)
Total	471	58 (12.3)	19 (4)	25 (5.3)	5 (1.1)	9 (1.9)

Table 2. Number and percentages of antimicrobial resistance of *Listeria* spp. isolated from duck and goose samples[1]

Item	Samples (No.)	Pen G (%)	AMC (%)	CL (%)	E (%)	GN (%)	TET (%)	VA (%)	R (%)	CD (%)	K (%)	R to 1 a.m.[2] (%)	R to 2 a.m.[3] (%)	R to >2 a.m.[4] (%)
Listeria spp.	Duck (41)	11 (26.8)	4 (9.8)	0	4 (9.8)	0	20 (48.8)	0	0	5 (12.2)	0	23 (56.1)	5 (12.2)	3 (7.3)
	Goose (17)	3 (17.6)	0	0	3 (17.6)	0	8 (47.1)	0	0	1 (5.9)	0	9 (52.9)	3 (17.6)	0
	Total (58)	14 (24.1)	4 (6.9)	0	7 (12.1)	0	28 (48.3)	0	0	6 (10.3)	0	32 (552)	8 (13.8)	3 (5.2)
Listeria monocytogenes	Duck (14)	4 (28.6)	1 (7.1)	0	1 (7.1)	0	8 (57.1)	0	0	2 (14.3)	0	7 (50)	3 (21.4)	1 (7.1)
	Goose (5)	2 (40)	0	0	1 (20)	0	3 (60)	0	0	0	0	4 (80)	1 (20)	0
	Total (19)	6 (31.6)	1 (5.3)	0	2 (10.5)	0	11 (57.9)	0	0	2 (10.5)	0	11 (57.9)	4 (21.1)	1 (5.3)
Listeria seeligeri	Duck (7)	1 (14.3)	0	0	0	0	2 (28.6)	0	0	0	0	3 (42.9)	0	0
	Goose (2)	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total (9)	1 (11.1)	0	0	0	0	2 (22.2)	0	0	0	0	3 (33.3)	0	0
Listeria innocua	Duck (4)	0	0	0	0	0	1 (25)	0	0	0	0	1 (25)	0	0
	Goose (1)	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total (5)	0	0	0	0	0	1 (20)	0	0	0	0	1 (20)	0	0
Listeria ivanovii	Duck (16)	6 (37.5)	3 (18.8)	0	3 (18.8)	0	9 (56.3)	0	0	3 (18.8)	0	12 (75)	2 (12.5)	2 (12.5)
	Goose (9)	1 (11.1)	0	0	2 (22.2)	0	5 (55.6)	0	0	1 (11.1)	0	5 (55.6)	2 (22.2)	0
	Total (25)	7 (28)	3 (12)	0	5 (20)	0	14 (56)	0	0	4 (16)	0	17 (68)	4 (16)	2 (8)

[1]Pen G: penicillin G; AMC: amoxicillin-clavulanic acid; CL: chloramphenicol; E: erythromycin; GN: gentamicin; TET: tetracycline; VA: vancomycin; R: rifampicin; CD: clindamycin; K: kanamycin.

[2]R to 1 a.m.: resistance to 1 antimicrobial.

[3]R to 2 a.m.: resistance to 2 antimicrobials.

[4]R to >2 a.m.: resistance to >2 antimicrobials.

Table 3. Number and percentages of isolates of serotypes of *Salmonella* from ducks and geese

Source	No. of samples	*Salmonella* Thompson	*Salmonella* Paratyphi C	*Salmonella* Enteritidis	*Salmonella* Hadar	*Salmonella* Virginia	*Salmonella* Typhimurium	Total
Duck	291	56 (59.6%)	6 (6.4%)	8 (8.5%)	7 (7.4%)	5 (5.3%)	2 (6.5%)	84 (28.9%)
Goose	180	14 (60.9%)	3 (13%)	2 (8.7%)	1 (4.3%)	3 (13%)	0	23 (12.8%)
Total	471	70 (65.4%)	9 (8.4%)	10 (9.3%)	8 (7.5%)	8 (7.5%)	2 (1.9%)	107 (22.7%)

Table 4. Number and percentages of antimicrobial resistance of serotypes of *Salmonella* isolated from ducks and geese[1]

Item	Samples (No.)	AMO (%)	AMP (%)	NAL (%)	TMP (%)	CL (%)	TET (%)	GN (%)	CIP (%)	STR (%)	COL (%)	R to 1 a.m.[2] (%)	R to 2 a.m.[3] (%)	R to >2 a.m.[4] (%)
Salmonella spp.	Duck (84)	6 (7.1)	3 (3.6)	33 (39.3)	24 (28.6)	5 (6)	54 (64.3)	0	0	22 (26.2)	0	18 (21.4)	14 (16.7)	26 (31)
	Goose (23)	1 (4.3)	1 (4.3)	10 (43.5)	6 (26.1)	0	14 (60.9)	0	0	10 (43.5)	0	7 (30.4)	1 (4.3)	9 (39.1)
	Total (107)	7 (6.5)	4 (3.7)	43 (40.2)	30 (28)	5 (4.7)	68 (63.6)	0	0	32 (29.9)	0	25 (23.4)	15 (14)	35 (32.7)
Salmonella	Duck (56)	4 (7.1)	2 (3.4)	21 (37.5)	18 (32.1)	4 (7.1)	39 (69.6)	0	0	19 (34)	0	10 (17.9)	8 (14.3)	21 (37.5)
Thompson	Goose (14)	0	1 (7.1)	8 (57.1)	6 (42.9)	0	11 (78.6)	0	0	9 (64.3)	0	3 (21.4)	1 (7.1)	8 (57.1)
	Total (70)	4 (5.7)	3 (4.3)	29 (41.4)	24 (34.3)	4 (5.7)	50 (71.4)	0	0	28 (40)	0	13 (18.6)	9 (12.9)	29 (41.4)
Salmonella	Duck (6)	0	1 (16.7)	2 (33.3)	2 (33.3)	0	4 (66.7)	0	0	3 (50)	0	1 (16.7)	1 (16.7)	2 (33.3)
Paratyphi C	Goose (3)	0	0	1 (33.3)	0	0	1 (33.3)	0	0	1 (33.3)	0	3 (100)	0	0
	Total (9)	0	1 (11.1)	3 (33.3)	2 (22.2)	0	5 (55.6)	0	0	4 (44.4)	0	4 (44.4)	1 (11.1)	2 (22.2)
Salmonella	Duck (8)	1 (12.5)	0	1 (12.5)	0	1 (12.5)	3 (37.5)	0	0	0	0	2 (25)	0	1 (12.5)
Enteritidis	Goose (2)	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total (10)	1 (10)	0	1 (10)	0	1 (10)	3 (30)	0	0	0	0	2 (20)	0	1 (10)
Salmonella	Duck (7)	0	0	4 (57.1)	2 (28.6)	0	3 (42.9)	0	0	0	0	3 (42.9)	3 (42.9)	0
Hadar	Goose (1)	0	0	0	0	0	1 (100)	0	0	0	0	1 (100)	0	0
	Total (8)	0	0	4 (50)	2 (25)	0	4 (50)	0	0	0	0	4 (50)	3 (37.5)	0
Salmonella	Duck (5)	1 (20)	0	3 (60)	2 (40)	0	4 (80)	0	0	0	0	1 (20)	1 (20)	2 (40)
Virginia	Goose (3)	1 (33.3)	0	1 (33.3)	0	0	1 (33.3)	0	0	0	0	0	0	1 (33.3)
	Total (8)	2 (25)	0	4 (50)	2 (25)	0	5 (62.5)	0	0	0	0	1 (12.5)	1 (12.5)	3 (37.5)
Salmonella	Duck (2)	0	0	2 (100)	0	0	1 (50)	0	0	0	0	1 (50)	1 (50)	0
Typhimurium	Goose (0)	0	0	0	0	0	0	0	0	0	0	0	0	0

[1]AMO: amoxicillin, AMP: ampicillin, NAL: nalidixic acid, TMP: trimethoprim, CL: chloramphenicol, TET: tetracycline, GN: gentamicin, CIP: ciprofloxacin, STR: streptomycin, COL: colisitin.

[2]R to 1 a.m.: resistance to 1 antimicrobial.

[3]R to 2 a.m.: resistance to 2 antimicrobials.

[4]R to >2 a.m.: resistance to >2 antimicrobials.

icillin-clavulanic acid (6.9%). All the isolates of *Listeria* spp. were susceptible to half of the antibiotic examined including chloramphenicol, gentamicin, vancomycin, rifampicin, and kanamycin.

Salmonella spp.

Distribution of Salmonella Serovars in Ducks and Geese. Out of 107 *Salmonella* spp., 84 (78.5%) and 23 (21.5%) isolates were detected from duck and goose samples, respectively (Table 3). There was a significant difference between contaminated duck and goose samples ($P < 0.05$). The most common serovar was *Salmonella* Thompson (65.4%). The remaining isolates were *Salmonella* Enteritidis (9.3%), *Salmonella* Paratyphi C (8.4%), *Salmonella* Hadar/*Salmonella* Virginia (7.5%), and *Salmonella* Typhimurium (1.9%).

Antimicrobial Resistance of Salmonella Serovars. The resistance profiles for the 107 *Salmonella* spp. are as follows: tetracycline, 63.6%; nalidixic acid, 40.2%; streptomycin, 29.9%; trimethoprim, 28%; amoxicillin, 6.5%; chloramphenicol, 4.7%; and ampicillin, 3.7%. However, all the *Salmonella* isolates were sensitive to colisitin, ciprofloxacin, and gentamicin (Table 4). Thirty-five (32.7%) isolates of *Salmonella* spp. were MDR. Multidrug resistance was more frequently observed among *Salmonella* Thompson as well as duck isolates. In addition, 42 (39.3%) *Salmonella* spp. isolates were susceptible to all of the examined antibiotics.

Yersinia spp.

Prevalence of Yersinia spp. in Ducks and Geese. Of 80 *Yersinia* spp. isolates, 58 (72.5%) and 22 (27.5%) isolates were detected from duck and goose samples, respectively (Table 5). The isolates of *Yersinia* spp. were identified as *Y. enterocolitica* (9.6%), *Y. frederiksenii* (4.5%), and *Y. intermedia* (4%). There was a significant difference between contaminated duck and goose samples ($P < 0.05$).

Antimicrobial Resistance of Yersinia spp. Isolates. The resistance profiles for the 80 *Yersinia* spp. are as follows: cephalothin, 51.3%; ampicillin, 21.3%; trimethoprim, 17.5%; amoxicillin, 11.3%; ciprofloxacin, 10%; nalidixic acid, 7.5%, streptomycin, 6.3%, and tetracycline, 2.9% each (see Table 6). All the isolates were sensitive to gentamicin and chloramphenicol. Thirteen (16.3%) isolates of *Yersinia* spp., including 8 *Yersinia enterocolitica*, 3 *Yersinia frederiksenii*, and 2 *Yersinia intermedia* isolates, were MDR. Moreover, 21 (36.3%) of the *Yersinia* spp. isolates were sensitive to all tested antibiotics.

DISCUSSION

Our results on the prevalence of *Listeria*, *Salmonella*, and *Yersinia* spp. demonstrated a high level of contamination among purchased duck and goose samples in Varamin, Tehran province, Iran. Our findings are in agreement with earlier findings, whereby Chipilev et al. (2010) and Adzitey et al. (2013) isolated *L. monocytogenes* and other species of *Listeria* from duck products and intestinal contents, respectively. However, no *Listeria* spp. was recovered from healthy indigenous ducks (Njagi et al., 2004). It is not clear whether ducks and geese are *Listeria* primary reservoirs or whether they were contaminated by environments. Several resources such as feces, soil, vegetation, and sewage have been reported as primary reservoir for *Listeria* species. *Listeria* spp. can survive and be transmitted to farm equipment and future flocks. Isolation of *L. monocytogenes* in the current study suggests that ducks and geese could be a potential risk of foodborne listeriosis in customers.

The prevalence of *Salmonella* spp. in duck samples is in agreement with earlier findings in Iran (Dilmaghani et al., 2011), the United Kingdom (Little et al., 2008), and Malaysia (Adzitey et al., 2012). Moreover, our results showed the high level of *Salmonella* contamination among ducks in Iran compared with the previous reports in other countries such as the United States (McCrea et al., 2006), China (Pan et al., 2010), Taiwan (Yu et al., 2008), and Egypt (Osman et al., 2010). *Salmonella* prevalence in ducks from Brazil was greater than our study (Hofer et al., 1997; Ribeiro et al., 2004). The high prevalence of *Salmonella* spp. in ducks could depend on environmental exposure and contact with other animals in the rearing area. However, a few reports regarding *Salmonella* prevalence in goose have been published. The prevalence of *Salmonella* spp. (12.8%) in our study was less than previously reported (32.6%) in Iran (Dilmaghani et al., 2011). Trawinska et al. (2008) and Pan et al. (2010) have isolated *Salmonella* spp. in goose samples in Poland and China, respectively.

Salmonella Thompson was the predominant serovar in this study as well as previously described in Iran (Soltan-Dallal et al., 2010). It is also considered as one of the most common serovars that causes infection and outbreaks. Two clinically significant *Salmonel-*

Table 5. Number and percentages (in parentheses) of isolates of serotypes of *Yersinia* from duck and goose samples

Source	No. of samples	*Yersinia enterocolitica*	*Yersinia fredreksenni*	*Yersinia intermediate*	Total
Duck	291	32 (11)	15 (5.2)	11 (3.8)	58 (19.9)
Goose	180	13 (7.2)	6 (3.3)	3 (1.7)	22 (12.2)
Total	471	45 (9.6)	21 (4.5)	14 (3)	80 (17)

Table 6. Number and percentages of antimicrobial resistance of serotypes of *Yersinia* isolated from duck and goose samples[1]

Item	Samples (No.)	AMO (%)	AMP (%)	NAL (%)	TMP (%)	CL (%)	TET (%)	GN (%)	CIP (%)	STR (%)	CEF (%)	R to 1 a.m.[2] (%)	R to 2 a.m.[3] (%)	R to >2 a.m.[4] (%)
Yersinia spp.	Duck (58)	7 (12.1)	13 (22.4)	5 (8.6)	9 (15.5)	0	15 (25.9)	0	7 (12.1)	4 (6.9)	33 (56.9)	20 (34.5)	7 (12.1)	10 (17.2)
	Goose (22)	2 (9.1)	4 (18.2)	1 (4.5)	5 (22.7)	0	8 (36.4)	0	1 (4.5)	1 (4.5)	8 (36.4)	6 (27.3)	6 (27.3)	2 (9.1)
	Total (80)	9 (11.3)	17 (21.3)	6 (7.5)	14 (17.5)	0	23 (28.8)	0	8 (10)	5 (6.3)	41 (51.3)	26 (32.5)	13 (16.3)	12 (15)
Y. enterocolitica	Duck (32)	5 (15.6)	7 (21.9)	5 (15.6)	6 (18.8)	0	12 (37.5)	0	5 (15.6)	4 (12.5)	21 (65.6)	9 (28.1)	5 (15.6)	7 (21.9)
	Goose (13)	2 (15.4)	2 (15.4)	1 (7.7)	2 (15.4)	0	5 (15.6)	0	1 (7.7)	0	6 (46.2)	1 (7.7)	3 (23.1)	2 (15.4)
	Total (45)	7 (15.6)	9 (20)	6 (13.3)	8 (17.8)	0	17 (37.8)	0	6 (13.3)	4 (8.9)	27 (60)	10 (22.2)	8 (17.8)	9 (20)
Y. fredreksenni	Duck (15)	1 (6.7)	4 (26.7)	0	1 (6.7)	0	3 (20)	0	2 (13.3)	0	11 (73.3)	7 (46.7)	1 (6.7)	3 (20)
	Goose (6)	0	1 (16.7)	0	2 (33.3)	0	3 (50)	0	0	0	2 (33.3)	4 (66.7)	2 (33.3)	0
	Total (21)	1 (4.8)	5 (23.8)	0	3 (14.3)	0	6 (28.6)	0	2 (9.5)	0	13 (61.9)	11 (52.4)	3 (14.3)	3 (14.3)
Y. intermediate	Duck (11)	1 (9.1)	2 (18.2)	0	2 (18.2)	0	0	0	0	0	1 (9.1)	4 (36.4)	1 (9.1)	0
	Goose (3)	0	1 (33.3)	0	1 (33.3)	0	0	0	0	1 (33.3)	0	1 (33.3)	1 (33.3)	0
	Total (14)	1 (7.1)	3 (21.4)	0	3 (21.4)	0	0	0	0	1 (7.1)	1 (7.1)	5 (35.7)	2 (14.3)	0

[1]AMO: amoxicillin, AMP: ampicillin, NAL: nalidixic acid, TMP: trimethoprim, CL: chloramphenicol, TET: tetracycline, GN: gentamicin, CIP: ciprofloxacin, STR: streptomycin, CEF: cephalothin.
[2]R to 1 a.m.: resistance to 1 antimicrobial.
[3]R to 2 a.m.: resistance to 2 antimicrobials.
[4]R to >2 a.m.: resistance to >2 antimicrobials.

la serovars, *Salmonella* Typhimurium and *Salmonella* Enteritidis, have been frequently reported as predominant serovars in many countries (Bennasar et al., 2000; Little et al., 2008; Trawinska et al., 2008; Pan et al., 2010; Osman et al., 2010; Adzitey et al., 2012). However, these serovars were not found as the predominant serovars in our study among duck and goose samples.

The prevalence of *Yersinia* spp. in foods and animals and its significance is still unknown in Iran (Hanifian and Khani, 2012). In this study, 9.6% of duck and goose samples were contaminated by *Yersinia* spp. To the best of our knowledge, there is no published information regarding to prevalence of *Yersinia* spp. in ducks and geese in Iran. However, a few studies have been reported the prevalence of *Yersinia* spp. in chicken and beef with the rate ranged of 13 to 16% (Soltan-Dallal et al., 2010; Yazdi et al., 2011). *Yersinia enterocolitica* was the predominant species in this study and is in agreement with earlier findings (Jiang and Kang, 2000; Capita et al., 2002; Soltan-Dallal et al., 2010; Yazdi et al., 2011; Hanifian and Khani, 2012).

Antimicrobial resistance in pathogens and therapeutic interference is always a significant issue in public health. The investigation of susceptibility pattern and antibiotic resistance is important to treatment (Soltan-Dallal et al., 2010). Antimicrobial agents that are used in growth promotion, treatment, or prophylaxis in poultry and broiler rearing have the potential to promote antimicrobial resistance among pathogens present. Therefore, antibiotic resistance strains could be transferred to humans via contaminated poultry products (Mayrhofer et al., 2004; Ezekiel et al., 2011).

Although only 3 isolates of *Listeria* spp. showed MDR in this study, more than half (55.2%) of all *Listeria* spp. isolates were resistant to at least one antibiotic agent. The MDR isolates were divided into *L. ivanovii* (66.7%) and *L. monocytogenes* (33.3%), and the susceptibility of *L. monocytogenes* isolates were observed in gentamicin, chloramphenicol, vancomycin, kanamycin, and rifampicin, which are in agreement with earlier findings (Hof and Emmerling, 1984; Srinivasan et al., 2005; Arslan and Özdemir, 2008; Conter et al., 2009). Furthermore, in an earlier study, susceptibility of food *L. monocytogenes* isolates to vancomycin and gentamicin also was reported (Harakeh et al., 2009).

In the current study, all *Salmonella* spp. isolates were sensitive to ciprofloxacin, which is in agreement with previous studies in Iran and other countries (Mayrhofer et al., 2004; Bhatia et al., 2007; Soltan-Dallal et al., 2010). Resistance to tetracycline and cephalothin was greater in *Salmonella* and *Yersinia* spp., respectively. A high prevalence of resistance to tetracycline in *Salmonella* was found by Yildirim et al. (2011) and Thai et al. (2012), whereas in an earlier study a low number of the pathogen showed resistance to tetracycline (Cook et al., 2011). Furthermore, a high prevalence of resistance to cephalothin in *Yersinia* spp. was reported by Bhaduri and Wesley (2012) and Bolton et al. (2013). Ciprofloxacin and tetracycline are used as disease treatment and

prevention, and a growth promoter in poultry rearing in Iran (Soltan-Dallal et al., 2010). Therefore, antimicrobial substances that are used for animal treatment could be reflected by antimicrobial resistance profile in foodborne pathogens.

In summary, the presence of *Listeria*, *Salmonella*, and *Yersinia* spp. in raw duck and goose intestinal contents showed that consumption of these kinds of meats could be a potential risk of foodborne listeriosis, salmonellosis, and yersiniosis in consumers. Thus, to decrease the prevalence of developed pathogen resistance, resistance monitoring and educational programs are required. Moreover, continual surveillance on the prevalence of the pathogens as well as on emerging antimicrobial resistance is needed to recognize foods that may represent risks and ensure the effective treatment of foodborne infections.

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