Turkish Journal of Veterinary & Animal Sciences

Volume 41 | Number 2 Article 8

1-1-2017

Serotypes of Salmonella isolated from feces of cattle, buffalo,and camel and sensitivities to antibiotics in Turkey

HASAN HÜSEYİN HADİMLİ

YASEMİN PINARKARA

ASLI SAKMANOĞLU

ZAFER SAYIN

OSMAN ERGANİŞ

See next page for additional authors

Serotypes of Salmonella isolated from feces of cattle, buffalo,and camel and sensitivities to antibiotics in Turkey

Authors
HASAN HÜSEYİN HADİMLİ, YASEMİN PINARKARA, ASLI SAKMANOĞLU, ZAFER SAYIN, OSMAN ERGANİŞ, ALİ USLU, and HUDA JIHAD AL-SHATTRAWI

TÜBİTAK

Turkish Journal of Veterinary and Animal Sciences

http://journals.tubitak.gov.tr/veterinary/

Research Article

Turk J Vet Anim Sci
(2017) 41: 193-198

doi:10.3906/vet-1604-67

Serotypes of *Salmonella* isolated from feces of cattle, buffalo, and camel and sensitivities to antibiotics in Turkey

Hasan Hüseyin HADİMLİ[1,*], Yasemin PINARKARA[2], Aslı SAKMANOĞLU[1], Zafer SAYIN[1], Osman ERGANİŞ[1], Ali USLU[1], Huda Jihad AL-SHATTRAWI[1]

[1]Department of Microbiology, Faculty of Veterinary Medicine, Selçuk University, Selçuklu, Konya, Turkey
[2]Department of Food Technology, Sarayönü Vocational School, Selçuk University, Sarayönü, Konya, Turkey

Received: 20.04.2016 • **Accepted/Published Online:** 19.10.2016 • **Final Version:** 19.04.2017

Abstract: In this study, *Salmonella* strains from dairy cows, calves with diarrhea, and buffalo and camel feces were isolated and serotyped. There were 869 feces samples (437 calves, 287 dairy cows, 100 buffalo, and 45 camels) collected from 13 provinces and 21 farms. Preenrichment feces samples were added to Rappaport-Vassiliadis medium. Samples were then subcultured on xylose lysine tergitol-4 agar and plates. Suspected colonies of *Salmonella* were confirmed by latex agglutination test. The isolates of *Salmonella* spp. were serotyped at the Etlik Central Veterinary Control Institute. In total, 40 *Salmonella* spp. were isolated, including 33 from calves, 5 from dairy cows, 1 from a buffalo, and 1 from a camel. *Salmonella* strains were serotyped as *S.* Kentucky (n = 23), *S.* Muenchen (n = 5), *S.* Anatum (n = 4), *S.* Gaminare (n = 4), *S.* Typhimurium (n = 1), *S.* Muenster (n = 1), *S.* Enteritidis (n = 1), and *S.* Abony (n = 1). The Kirby-Bauer disk diffusion method was used for the determination of antibiotic susceptibilities of isolates against 15 antibiotics. *Salmonella* isolates were determined as resistant to multiple antibiotics. In conclusion, 8 different *Salmonella* serotypes were found in dairy cows, calves, buffalo, and camels. Because of the occurrence of multiresistant isolates, biosafety measures and pathogen control processes are advised for *Salmonella*-associated risks to public health.

Key words: *Salmonella*, serotyping, dairy cow, calf, and buffalo

1. Introduction

Salmonellosis is a common bacterial enteric infection with significant economic losses for the intensive production of cattle, sheep, and poultry (1,2). *Salmonella* species are zoonotic and are transmitted to humans via ingestion of contaminated milk, eggs, and meat (3,4). Although *Salmonella* infections may occur at any age in cattle, the associated clinical symptoms are more severe in calves from the first 2 weeks to 3 months of their life (5,6).

Salmonella enterica subsp. *enterica* may cause infections associated with several clinical symptoms or systemic infections characterized by diarrhea and septicemia and may even lead to death in severe cases. It can be harbored by asymptomatic carriers (2,5). In the enteric form of salmonellosis, the stool is sticky and watery and has a putrid odor. It may contain flecks of mucus, shreds of the mucous membrane, and in some cases blood. Young calves and lambs frequently develop septicemia. Furthermore, marked depression, fever, symptoms of the central nervous system, pneumonia, and death within 2–3 days can also occur (7–9).

Clinical symptoms and necropsy findings alone are not sufficient for a definitive diagnosis of *Salmonella* infection. It is imperative to isolate and identify the causative *Salmonella* species (10–12). While the isolation of *Salmonella* is relatively easy via bacterial culture from samples taken from animals with septicemia, carcasses, and the organs of aborted fetuses, enrichment is needed to increase the chance of isolating *Salmonella* from feed samples or from fecal cultures used to detect carriers (7,13,14).

This study aimed to isolate and serotype *Salmonella* species from fecal samples of dairy cattle, calves with diarrhea, camels, and water buffaloes and to determine sensitivities of the isolates to antibiotics.

2. Materials and methods

2.1. Sampling

A total of 869 fecal samples were collected from 21 herds in 13 provinces (Konya, Kayseri, Düzce, Kahramanmaraş, Şanlıurfa, Amasya, Aksaray, Adıyaman, Afyonkarahisar, Aydın, Kırşehir, Niğde, and İzmir) in Turkey. Of these, 437

* Correspondence: hhadimli@selcuk.edu.tr

were taken from calves, 287 from dairy cattle, 100 from water buffaloes, and 45 from camels. These samples were transferred under cold-chain conditions and within the shortest time possible to the laboratory of the Microbiology Department of Selçuk University, Faculty of Veterinary Medicine, in Turkey.

2.2. Microbiological examination

Detection of the presence of *Salmonella* spp. was carried out according to the ISO 6579 standard. For preenrichment, the fecal samples were cultured in 1:10 buffered peptone and water (2.5 g of feces and 22.5 mL of medium) and incubated at 37 °C for 24 h. Subsequently, selective enrichment was performed by culturing 1 mL of sample into Rappaport-Vassiliadis medium. The culture was incubated at 42 °C for 24 h. Finally, for selective culturing, the samples were passaged onto xylose lysine deoxycholate (XLD) and/or xylose lysine tergitol-4 (XLT-4) agar and incubated at 37 °C for 24–48 h. Colorless or light pink colonies with darker centers on XLD agar or black colonies on XLT-4 agar were suspected of being *Salmonella* (15,16).

2.3. Serological confirmation and serotyping

Microorganisms suspected of being *Salmonella* strains were tested with a *Salmonella* latex agglutination kit (17,18). The *Salmonella* isolates that gave positive results by the latex agglutination test were serotyped at the Etlik Central Veterinary Control Institute.

2.4. Antibiotic sensitivity test

The antibiotic sensitivity tests of the *Salmonella* isolates were performed by by the Kirby-Bauer disk diffusion method using oxytetracycline (30 µg), gentamycin (10 µg), erythromycin (15 µg), cefuroxime (30 µg), chloramphenicol (30 µg), danofloxacin (5 µg), ampicillin (25 µg), amoxicillin (25 µg), cephalexin (30 µg), kanamycin (75 µg), spectinomycin G (10 U), ceftiofur (30 µg), lincomycin+spectinomycin (10 µg), enrofloxacin (5 µg), and rifamycin (30 µg) disks and Mueller-Hinton agar (19). The results were evaluated after the media were incubated at 37 °C for 48 h.

3. Results

Salmonella strains were isolated from 8 herds (61.5%); 40 (4.60%) *Salmonella* isolates were recovered from 869 fecal samples (Table 1). *Salmonella* strains were isolated from calves (7.5%, 33/437), dairy cows (1.74%, 5/287), a buffalo (1%, 1/100), and a camel (2.22%, 1/45).

Salmonella isolates in calves were serotyped as *S.* Kentucky (8,20:i:z_6) (n = 19), *S.* Muenchen (6,8:d:1,2) (n = 5), *S.* Gaminare (16:d:1,7) (n = 4), *S.* Anatum (3,10,[15],[15,34]:e,h:1,6) (n = 3), *S.* Enteritidis (1, 9,12: g,m:-) (n = 1), and *S.* Muenster (3,10[15][15,34]:e,h:1,5) (n = 1). *Salmonella* isolates in dairy cows were serotyped as *S.* Kentucky (8,20:i:z_6) (n = 3), *S.* Anatum (3,10,[15],[15,34]:e,h:1,6) (n = 1), and *S.* Typhimurium (1,4,[5],12:i:1,2) (n = 1). In addition, 1 isolate in buffalo was *S.* Kentucky (8,20:i:z_6) and the 1 isolate in camel was *S.* Abony (1,4,[5],12,27:b:e,n,x) (Table 1).

All *Salmonella* isolates were resistant to one or more antibiotics. All *Salmonella* serotypes were resistant to erythromycin and rifamycin. In addition, all *Salmonella* serotypes (except *S.* Abony) were resistant to amoxicillin. *S.* Enteritidis was resistant to 10 antibiotics; *S.* Gaminare to 8; *S.* Abony to 6; *S.* Kentucky, *S.* Anatum, *S.* Typhimurium, and *S.* Muenchen to 4; and *S.* Muenster to 3. However, all *Salmonella* serotypes were susceptible to cefuroxime and ceftiofur (Table 2).

4. Discussion

Salmonella enterica subsp. *enterica* is a food pathogen that may cause disease in both people and animals (3,5,20). Some of the *Salmonella* species are host-specific. They

Table 1. *Salmonella* serotypes.

Serotype	Calf	Dairy Cow	Buffalo	Camel	Total
S. Kentucky	19	3	1	-	23
S. Anatum	3	1	-	-	4
S. Muenchen	5	-	-	-	5
S. Typhimurium	-	1	-	-	1
S. Abony	-	-	-	1	1
S. Enteritidis	1	-	-	-	1
S. Gaminare	4	-	-	-	4
S. Muenster	1	-	-	-	1
Total	33	5	1	1	40

Table 2. The sensitivity of *Salmonella* serotypes to antimicrobial agents.

Antibiotics	*S.* Kentucky			*S.* Muenchen			*S.* Anatum			*S.* Typhimurium			*S.* Abony			*S.* Enteritidis		*S.* Gaminare			*S.* Muenster		
	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R	S	R	S	I	R	S	I	R
SEF	23	-	-	5	-	-	4	-	-	1	-	-	-	1	-	1	-	4	-	-	1	-	-
ENR	-	1	22	5	-	-	4	-	-	1	-	-	1	-	-	1	-	4	-	-	1	-	-
AML	-	-	23	-	-	5	-	-	4	-	-	1	1	-	-	-	1	-	4	-	-	-	1
C	23	-	-	5	-	-	4	-	-	1	-	-	1	-	-	-	1	4	-	-	1	-	-
AMP	1	-	22	-	-	5	-	-	4	-	-	1	1	-	-	-	1	-	4	-	-	1	-
E	-	-	23	-	-	5	-	-	4	-	-	1	-	-	1	-	1	-	-	4	-	-	1
CL	6	11	6	5	-	-	1	3	-	-	1	-	-	1	-	-	1	-	-	4	1	-	-
LCS	-	-	23	5	-	-	-	4	-	1	-	-	-	-	1	-	1	-	-	4	1	-	-
OT	1	-	22	5	-	-	2	1	1	1	-	-	1	-	-	-	1	-	-	4	-	1	-
K	5	14	4	5	-	-	2	2	-	1	-	-	-	-	1	-	1	-	-	4	1	-	-
S	-	1	22	3	2	-	-	2	2	-	1	-	-	-	1	-	1	-	-	4	1	-	-
DFX	-	1	22	5	-	-	4	-	-	1	-	-	1	-	-	1	-	4	-	-	1	-	-
EFT	23	-	-	5	-	-	4	-	-	1	-	-	1	-	-	1	-	4	-	-	1	-	-
RA	-	-	23	-	-	5	-	-	4	-	-	1	-	-	1	-	1	-	-	4	1	-	-
CN	2	-	21	2	2	1	2	1	1	1	-	-	-	-	1	1	-	-	-	4	-	-	1
Total	23			5			4			1			1			1		4			1		

SEF: Cefuroxime, ENR: enrofloxacin, AML: amoxicillin, C: chloramphenicol, AMP: ampicillin, E: erythromycin, CL: cephalexin, LCS: lincomycin+spectinomycin, OT: oxytetracycline, K: kanamycin, S: spectinomycin, DFX: danofloxacin, EFT: ceftiofur, RA: rifamycin, CN: gentamycin.

can be asymptomatic or can cause death (9,21). There are over 2500 *Salmonella* serovars and, due to the diversity of host types, *Salmonella* control is compulsory in animal production (22). Infected animals may spread the agent through feces without showing any clinical symptoms (23).

For *Salmonella* isolation, three cultural procedure stages are generally used: preenrichment, selective enrichment, and selective culture (15,16). In the preenrichment stage, the most commonly used media are buffered peptone water (BPW) and lactose broth (15). In selective enrichment, media that support production of *Salmonella* and inhibit production of other bacteria are used. Media such as tetrathionate broth, selenite-cysteine broth, selenite broth, and Rappaport-Vassiliadis broth are widely used (15). In selective culture, MacConkey agar, *Salmonella-Shigella* agar, XLD agar, Rambach agar, and XLT-4 agar could be used (15,16). In this study, BPW was used for preenrichment. For selective enrichment, Rappaport-Vassiliadis broth was used, and XLT-4 and XLD agar was used for the isolation of *Salmonella* species.

The source of *Salmonella*-based diseases in people is often subclinically infected local dairy cattle (22,24). Cattle are the most important *Salmonella* reservoir agents and consumption of infected cattle meat is related to salmonellosis epidemics (25). Various studies were carried out to isolate and serotype *Salmonella* from dairy cattle and calves (4,7,14,18,21,22,24). Several researchers (4,7,14,18,21,22,24) reported that *Salmonella* isolates were identified as *S.* Typhimurium, *S.* Dublin, *S.* Agona, *S.* Orion, *S.* Aintpul, *S.* Braenderup, *S.* Muenchen, *S.* Croft, *S.* Kentucky, *S.* Telaviv, *S.* Montevideo, *S.* Kpeme, *S.* Infantis, *S.* Abadina, *S.* Cerro, *S.* Mismarhaenek, *S.* Enteritidis, *S.* Guildford, *S.* Anatum, *S.* Gozo, *S.* Mbandaka, *S.* Senftenberg, *S.* Newport, *S.* Give, and *S.* Muenster.

Fecal *Salmonella* studies in Turkey are usually based on slaughterhouse samples or case-based notices. Gökçen et al. (26) isolated *S.* Typhimurium from the small bowel contents of only one cow out of 298 cattle. Akbarut (27) did not isolate *Salmonella* from fecal samples of 119 cattle. Genç (14) isolated *Salmonella* in 0.7% of 1000 feces samples obtained from cattle slaughtered in Kars. They were serotyped as *S.* Enteritidis (n = 5) and *S.* Typhimurium (n = 1). Erganiş et al. (10) isolated *S.* Typhimurium from the internal organs of 2 feedlot calves with septicemia. Canpolat and Akan (28) isolated only 1 (0.9%) *Salmonella* sp. from fecal samples of 106 cattle. Hadimli et al. (9) reported that 3 *S.* Dublin specimens were isolated from liver, spleen, and mesenteric lymph node samples of dead calves.

In our study, fecal samples were collected from calves and dairy cattle with diarrhea from 13 provinces and 21 different enterprises. *Salmonella* spp. was isolated from 8 (38.09%) out of 21 enterprises and 40 (4.6%) out of 869 fecal samples. Thirty-three isolates were isolated from calves, 5 from dairy cows, 1 from buffalo, and 1 from camel. Nineteen of the calves' isolates were *S.* Kentucky, 5 were *S.* Muenchen, 4 were *S.* Gaminare, 3 were *S.* Anatum, 1 was *S.* Enteritidis, and 1 was *S.* Muenster. Three isolates from dairy cattle were *S.* Kentucky, 1 was *S.* Anatum, and 1 was *S.* Typhimurium. *S.* Kentucky was the most commonly isolated serotype.

Any clinical signs and death for salmonellosis were observed in sampling dairy cows and buffaloes. Sampling was done considering that these animals may have had salmonellosis as reservoirs. Three isolates and one isolate were isolated from dairy cows and buffalo, respectively. Three different Salmonella serotypes (*S.* Kentucky, *S.* Anatum, and *S.* Typhimurium) were determined. *S.* Gaminare, *S.* Muenchen, *S.* Enteritidis, and *S.* Muenster isolates were separately isolated each from a single enterprise. Any clinical signs and death for salmonellosis were observed in sampling calves. *S.* Anatum isolates were recovered from different enterprises, and 2 isolates were isolated from calves and one isolate from a dairy cow. *S.* Kentucky isolates in an enterprise including dairy cows, calves, and buffaloes were isolated from calves with widely observed cases of diarrhea and death. In this enterprise, 19, 3, and 1 *S.* Kentucky isolates were recovered from calves, dairy cows, and buffaloes, respectively. *S.* Typhimurium was also isolated from the same enterprise. Moreover, *S.* Abony was isolated from a camel.

Salmonella infections have a subclinical course. There are isolates with resistance against multiple antibiotics (5,29,30). Vella and Cushieri (21) stated that all of 131 *Salmonella* isolates were susceptible to all antibiotics; the most resistance was observed with trimethoprim. McEvoy et al. (20) stated that *S.* Typhimurium isolates were resistant to ampicillin, chloramphenicol, streptomycin, sulfafurazole, and tetracycline and *S.* Dublin and *S.* Agona isolates were sensitive to antibiotics. Addis et al. (30) reported that *Salmonella* strains isolated from fecal and milk samples of dairy cattle were resistant to ampicillin (100%), streptomycin (66.7%), and nitrofurazone (58.3%) and sensitive to ciprofloxacin (91.7%), clotrimazole (87.5%), and cephaxon (75%). Gorski et al. (25) stated that *Salmonella* isolates were sensitive to 12 different antibiotics. Wieczorek and Osek (24) stated that some of the *S.* Dublin, *S.* Enteritidis, and *S.* London strains were resistant to sulfamethizole. *S.* Typhimurium is resistant to multiple antibiotics (ampicillin, streptomycin, tetracycline, and sulfamethizole) (24). Rodriquez-Rivera et al. (3) reported that 90 *Salmonella* strains (23.6%) out of 381 from subclinically infected dairy cattle and environmental samples were resistant to antibiotics varying from 1 and 11. All of the isolated strains were sensitive to amikacin and ciprofloxacin, and the highest resistance was against ampicillin (72%), tetracycline (63%), and amoxicillin+clavulanic acid (58%). Moreover, different serotypes or serovars may be included in strains that are resistant to antibiotics.

In the present study, we found that *Salmonella* strains were resistant to multiple antibiotics. All *S.* Kentucky isolates were resistant to amoxicillin, erythromycin, lincomycin+spectinomycin, and rifamycin; the *S.* Muenchen isolates were resistant to amoxicillin, ampicillin, erythromycin, and rifamycin. The *S.* Typhimurium isolate was resistant to amoxicillin, ampicillin, erythromycin, and rifamycin; the *S.* Abony isolate was resistant to lincomycin+spectinomycin, kanamycin, spectinomycin, erythromycin, rifamycin, and gentamycin; *S.* Enteritidis was resistant to amoxicillin, chloramphenicol, ampicillin, erythromycin, cephalexin, lincomycin+spectinomycin, oxytetracycline, kanamycin, spectinomycin, erythromycin, and rifamycin; all the *S.* Gaminare isolates were resistant to erythromycin, cephalexin, lincomycin+spectinomycin, oxytetracycline, kanamycin, spectinomycin, rifamycin, and gentamycin; and *S.* Muenster was resistant to amoxicillin, erythromycin, and gentamycin.

In conclusion, *Salmonella* is present in cows, calves, buffaloes, and camels in Turkey. For public health, biosafety measures and pathogen control processes are needed.

Acknowledgments

This study is a part of a project supported by TÜBİTAK-TOVAG (Project No: 112O324). This study was previously presented in part as an oral presentation at the XI. Veteriner Hekimleri Mikrobiyoloji Kongresi, 2014, Kemer, Antalya, Turkey (pp. 24–25). The study was approved by the Ethics Committee of the Faculty of Veterinary Medicine at Selçuk University in Konya, Turkey.

References

1. Kirk J, Atwill E, Holmberg C, Arana M, Collar C, Ghirardelli D, Higginbotham G, Markagaard G, Mullinax D, Wubishet A. Prevalence of and risk factors for *Salmonella* in water offered to weaned dairy calves in California, USA. Prev Vet Med 2002; 54: 169-178.
2. Smith-Palmer A, Stewart WC, Mather H, Greig A, Cowden A, Cowden JM, Reilly WJ. Epidemiology of *Salmonella enterica* serovars Enteritidis and Typhimurium in animals and people in Scotland between 1990 and 2001. Vet Rec 2003; 153: 517-520.
3. Rodriquez-Rivera LD, Wright EM, Siler JD, Elton M, Cummings KJ, Warnick LD, Wiedmann M. Subtype analysis of *Salmonella* isolated from subclinically infected dairy cattle and dairy farm environments reveals the presence of both human-and-bovine associated subtypes. Vet Microbiol 2014; 170: 307-316.
4. Molla B, Alemayehu D, Salah W. Sources and distribution of *Salmonella* serotypes isolated from food animals, slaughterhouse personnel and retail meat product in Ethiopia: 1997-2002. Ethiopian Journal of Health Development 2003; 17: 63-70.
5. Berge ACB, Thornburg E, Adaska JM, Moeller RB, Blanchard PC. Antimicrobial resistance in *Salmonella enterica* subspecies *enterica* serovar Dublin from dairy source calves in the central San Joaquin Valley, California (1998–2002). J Vet Diagn Invest 2008; 20: 497-500.
6. Rice DH, Besser TE, Hancock DL. Epidemiology and virulence assessment of *Salmonella* Dublin. Vet Microbiol 1997; 56: 111-124.
7. Alam MJ, Ranter DG, Ives SE, Thomson DU, Sanderson MW, Hollis LC, Nagaraja TG. Potential associations between fecal shedding of *Salmonella* in feedlot cattle treated for apparent respiratory disease and subsequent adverse health outcomes. Vet Res 2009; 40: 1-13.
8. Gragg SE, Loneragan GH, Nightingale KK, Brichta-Harhay DM, Ruiz H, Elder JR, Garcia LG, Miller MF, Echeverry A, Porras RGR et al. Substantial within animal diversity of *Salmonella* isolates from lymph nodes, feces and hides of cattle at slaughter. Appl Environ Microbiol 2013; 79: 4744-4750.
9. Hadimli HH, Sayın Z, Erganiş O. Buzağılarda *Salmonella* Dublin enfeksiyonu ve otojen aşı uygulaması ile kontrolü. Eurasian J Vet Sci 2011; 27: 99-105 (in Turkish with English abstract).
10. Erganiş O, Corlu M, Hadimli HH, Kav K. Development and therapeutic effects of inactivated *Salmonella* and *Klebsiella* vaccine for beef cattle: a preliminary report. In: Condition and Perspectives of Veterinary Science and Practice Development Materials International Scientific and Research Conference; Almaty, Kazakhstan; 2003. pp. 96-100.
11. Fossler CP, Wells SJ, Kaneene JB, Ruegg PL, Warnick LD, Bender JB, Eberly LE, Godden SM, Halbert LW. Herd-level factors associated with isolation of *Salmonella* in a multi-state study of conventional and organic dairy farms I. *Salmonella* shedding in cows. Prevent Vet Med 2005; 70: 257-277.
12. Fossler CP, Wells SJ, Kaneene JB, Ruegg PL, Warnick LD, Bender JB, Eberly LE, Godden SM, Halbert LW. Herd-level factors associated with isolation of *Salmonella* in a multi-state study of conventional and organic dairy farms II. *Salmonella* shedding in calves. Prevent Vet Med 2005; 70: 279-291.
13. Callaway TR, Keen JE, Edrington TS, Baumgard LH, Spicer L, Fonda ES, Griswold KE, Overton TR, VanAmburgh ME, Anderson RC et al. Fecal prevalence and diversity of *Salmonella* species in lactating dairy cattle in four states. J Dairy Sci 2005; 88: 3603-3608.
14. Genç O. Kars yöresinde evcil hayvanlardan *Salmonella*'ların izolasyonu, identifikasyonu ve serotiplendirilmesi. Kafkas Univ Vet Fak Derg 2002; 8: 23-30 (in Turkish with English abstract).
15. Maddoks S, Olma T, Chen S. Comparison of CHROM agar *Salmonella* medium and xylose-lysine-desoxycholate and *Salmonella-Shigella* agars for isolation of *Salmonella* strains from stool samples. J Clin Microbiol 2002; 40: 2999-3003.
16. Nye KJ, Frodsham D, Gee B, Howells K, Iliffe A, Turner T, Warren RE, Andrews S. Comparison of the performance of selenite cystine and mannitol selenite enrichment broths in the isolation of *Salmonella* spp. from faeces. Commun Dis Public Health 2003; 6: 294-296.
17. Edrington TS, Schultz CL, Bischoff KM, Callaway TR, Looper ML, Genovesek J, Jung YS, McReynolds JL, Anderson RC, Nisbet DJ. Antimicrobial resistance and serotype prevalence of *Salmonella* isolated from dairy cattle in the southwestern United States. Microb Drug Resist 2004; 10: 51-56.
18. Sato K, Carpenter TE, Case JT, Walker RL. Spatial and temporal clustering of *Salmonella* serotypes isolated from adult diarrheic dairy cattle in California. J Vet Diagn Invest 2001; 13: 206-212.
19. Clinical and Laboratory Standards Institute**.** Performance Standards for Antimicrobial Susceptibility Testing; Twenty-Third Informational Supplement M100-S23. Wayne, PA, USA: Clinical and Laboratory Standards Institute; 2013.
20. McEvoy JM, Doherty AM, Sheridan JJ, Blair IS, McDowell DA. The prevalence of *Salmonella* spp. in bovine faecal, rumen and carcass samples at a commercial abattoir. J App Microbiol 2003; 94: 693-700.
21. Vella L, Cushieri P. *Salmonella* excretion in adult cattle on the Maltese island of Gozo. Rev Sci Tech 1995; 14: 777-787.
22. Nielsen LR. Within-herd prevalence of *Salmonella* Dublin in endemically infected dairy herds. Epidemiol Infect 2013; 141: 2074-2082.
23. Wells SJ, Fedorkac PJ, Dargatz DA, Ferris K, Green A. Fecal shedding of *Salmonella* ssp. by dairy cows on farm and at cull cow markets. J Food Prot 2001; 64: 3-11.
24. Wieczorek K, Osek J. Prevalence and characterisation of *Salmonella* in slaughtered cattle and beef in Poland. Bull Vet Ins Pulawy 2013; 57: 607-611.

25. Gorski L, Parker CT, Liang A, Cooley M, Jay-Russell MT, Gordus AG, Atwill ER, Mandrell RE. Prevalence, distribution and diversity of *Salmonella enterica* in a major produce region of California. Appl Environ Microbiol 2011; 77: 2734-2748.

26. Gökçen S, Denizli AN, Erturun H. İzmir–Manisa mezbahalarında kesilen sığırlarda *Salmonella* etkenlerinin izolasyonu. Bornova Veteriner Kontrol ve Araştırma Enstitüsü Müdürlüğü Dergisi 1995; 33: 85- 96 (in Turkish with English abstract).

27. Akbarut A. Bursa bölgesindeki sığırlardan izole edilen *Salmonella* türleri üzerine bakteriyolojik ve serolojik çalışmalar. PhD, Uludağ University, Bursa, Turkey, 1996 (in Turkish).

28. Canpolat S. Çeşitli hayvan dışkılarından *Salmonella* etkenlerinin konvansiyonel ve moleküler yöntemlerle saptanması. PhD, Ankara University, Ankara, Turkey, 2007 (in Turkish).

29. Izzo MM, Mohler VL, House JK. Antimicrobial susceptibility of *Salmonella* isolates recovered from calves with diarrhoea in Australia. Aust Vet J 2011; 89: 402-408.

30. Addis Z, Kebede N, Sisay Z, Alemayehu H, Yirsaw A, Kassa T. Prevalence and antimicrobial resistance of *Salmonella* isolated from lactating cows and in contact in dairy farms of Addis Ababa: a cross sectional study. BMC Inf Dis 2011; 222: 1-7.