Review

Journal of Food Safety and Hygiene

The occurrence of *Salmonella* contamination in food in Iran during 2012 to 2022; a review

Mahtab Sanei Darani[1], Ebrahim Molaee-Aghaee[2,3], Marziyeh Palizban[4*]

[1]Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran.
[2]Division of Food Safety and Hygiene, Department of Environmental Health Engineering, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran
[3]Department of Food Science and Technology, School of Nutritional Sciences and Dietetics, Tehran University of Medical Sciences, Tehran, Iran.
[4]Department of Food Hygiene and Control, School of Veterinary Medicine, Tehran University, Tehran, Iran.

ARTICLE INFO	ABSTRACT
	Salmonella infection is a main public health difficult in the world. This zoonotic bacterial disease in most parts of the world, specifically in developing countries have so more importance. Treatment of *salmonella* infection be more difficult versus past years. The aim of this review is determining provinces that reported the most amount of contaminated food samples and the antibiotics that had the most and least resistance against *salmonella* in Iran. The data were collected from Scopus, PubMed, Google Scholar and Science Direct. The selected keywords were "*Salmonella*" and "Iran" in both English and Persian languages. The percentage of contamination by *Salmonella* was in a range from 68.8% to 0% and resistance against *Salmonella* bacteria were observed in a range from 100% resistant (Pleuromutilins, Penicillins & Macrolides) to 100% sensitive in (Aminoglyco-sides & Cephalosporins). Resistance to antibiotics is an important alarm for public health because of their application in treatment human salmonellosis cases.

1. Introduction

Diseases transmitted through food still have a significant impact on people's health as one of the most vital health problems (1). Travel Increasing, development of tourism, consumption of food outside the home, consumption of prepared and packaged foods; caused Foodborne diseases have been raised as a major problem in global health (2). The most common cause of diseases transmitted by food are

*Corresponding author. Tel.: 989102007609
E-mail address: mpalizban@ymail.com

toxins, viruses, bacteria and parasites (3). Salmonellosis is responsible for the most cases of the deaths caused by food-borne diseases in the world and is a fundamental problem in developing countries as well as in developed countries (4). The natural habitat of *salmonella* is the digestive system of mammals (5). The sewage inflow into aquaculture waters or the usage animal fertilizers can induce to an increase in possibility of food contamination with *salmonella* (6). The three most common types of disease caused by *Salmonella* in humans include enteric fever, enteritis, and extra-intestinal infection (7). This bacterium causes an average of twenty-five million infections and about two hundred thousand deaths worldwide (8). CDC approximates *Salmonella* bacteria cause about 1.35 million infections, 26,500 hospitalizations, and 420 deaths in the United States every year and food is the source for great part of these illnesses (9). Despite the identification more than 2500 serotypes of *Salmonella* the infection caused by that in humans is a small number of its serotypes. *Salmonella enteritidis* and either *Salmonella typhimurium* have shown the most cases of isolation from food in the America and Europe outbreaks (10). According to the statistics of the last decade, Jakarta, India, Pakistan and Nepal are the most polluted areas in the world with *salmonella* (11). Epidemiological studies in different parts of the world indicate an increase in infections caused by *Salmonella* serovars, which have very high drug resistance (12). The most infections of *salmonella* have occurred due to the contamination of foods with animal origin, poultry, red meat and their products so foods are considered as a factor for *salmonella* transmission to humans (13). Since *Salmonella* are sensitive to sunlight and dryness, their survival in the environment depends on

temperature and humidity (11) so if enough temperature and cooking time are applied, it will be destroyed. But in the food such as mushrooms, red meat or chicken meat and vegetables if the heat not to be enough, *salmonella* will survive especially when they have a high initial contamination (14).

Mindful the importance of *Salmonella* serotypes in human public health is the purpose of this review to access determining the percentage of *Salmonella* contamination in tested foods located in the states of Iran. Determining the states which had the most contaminated food samples and the antibiotics that had the most and least resistance against *salmonella* by way of a survey of accomplished articles in Iran.

2. Methods

2.1. Ethical approval, study method and search strategy

This is a review of the published studies and ethical approval is not needed for this study.

The current study is a comprehensive review on the prevalence of *Salmonella* in foods that consumed by people in Iran from 2012 to 2022. In 2022, a comprehensive methodical search was executed in 4 valid international databases include Scopus, PubMed, Google Scholar and Science Direct. The selected keywords were "*Salmonella*," and "Iran" in both English and Persian languages. A total of 529 articles were considered. After revising the titles of the articles, 101 relevant articles were known and entered the qualitative evaluation stage of the articles. Finally, at the end of this stage, 33 articles stayed.

2.2. Inclusion-exclusion criteria and data extraction

Amongst drew out studies, some of them were kept out from the archive of received ones: rundown of presented articles at the congress, the studies that

abstract and full texts were not accessible, review articles, studies with no patently stated data and studies that are not original. Additionally, articles were excluded if samples were collected from non-edible stuff. From each article, some information including study's location and date, type of food and packaging, percentage rate of positive cases, the type of antibiotics and the percentage of resistance to *Salmonella* bacteria were entered into the pre-designed tables. Then, the data were categorized and analyzed; statistically.

2.3. Statistical investigation

Data investigation was done by use of SPSS software, version 25. The diagrams were drawn in Excel 2019 software.

3. Identified studies

In current study, the contamination rates were analyzed in 20 geographical regions of Iran. *Salmonella* detection have done by use of different Methods.

Respectively, the highest percentage of contamination by *Salmonella* was 68.8% in Nikshahr and the lowermost contamination rate was 0% (in Maragheh, Mahabad, the provinces of Azarbaijan and Mazandaran).

Also, the highest and lowest rates of *Salmonella* contamination have been reported in Tahini (75%) and raw goat milk (2%), respectively.

Although the percentage of *Salmonella* infection was variable in the decade of research, generally; it increased from 8% to 45% (chart No. 1).

The highest and lowest levels of antibiotic resistance against *Salmonella* bacteria were observed in Ardabil city and Tehran city, respectively. The amount of antibiotic resistance in the samples which isolated *Salmonella* bacteria were tested; observed in a high

range resistant about Pleuromutilins, Penicillins & Macrolides to a high range sensitive about Aminoglycosides & Cephalosporins.

The percentage of cumulative contamination in food samples during the decade under study according to the provinces that have conducted *Salmonella* detection test is given in Chart No. 2. It should be noted that in some examples Such as Tahini, non-pasteurized ice cream, pasteurized cream, pasteurized milk, Dough, raw camel milk, buffalo milk, butter, rice pudding, yogurt and frozen fish *Salmonella* infection was zero percent.
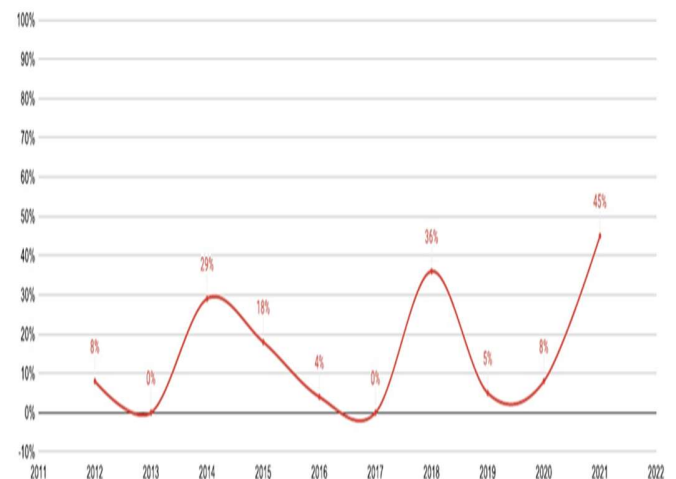

Figure 1. The average percentage of contamination in the research decade (2012-2022) (11, 14-45).
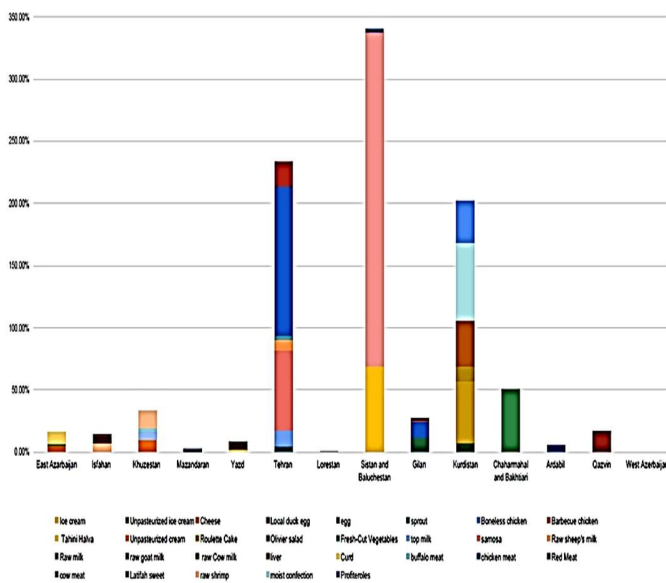
Figure 2. The cumulative of *Salmonella* contamination in food samples in the research decade (2012-2022) (11, 14-45).

4. Review recent studies

Salmonella isolates are among the most important food-borne pathogens that are largely transferred to humans via intake of deferent food substances. We conducted this revision to probe the prevalence of *Salmonella* contamination in food that used in Iran from different edible stuffs and provinces. In this study, cities with the highest and lowest levels of contamination to *Salmonella* were identified. The range of contamination in food was also determined from 75% to 0%. Unfortunately, this review showed an increase in the amount of pollution in the decade under study.

Similar results to our study; several independent studies in Iran showed that *Salmonella* strains isolated from deferent foods. For example the survey on Occurrence of *Salmonella* contamination in consumed eggs in Iran showed that the highest rate of contamination went to the industrial eggs (7.49%). The total prevalence of *Salmonella* contamination in consumed eggs of Iran using culture of microbial, molecular-serological, molecular, culture-molecular, culture-serological, and culture-molecular-serological methods was shown 11.33%, 5.52%, 0.37%, 1.91%, 5.52%, and 0.73%, respectively. Occurrence in the twenty-one geographical zones, where studies have been piloted, alternated from 0% to 29.06% (46).

Another study on Multidrug-unaffected by *Salmonella* strains from food animals in Iran revealed that totally, 105 *Salmonella* isolates were gained from chicken meat (70.0%), beef (19.0%), lamb (11.0%), and human stool (1.7%). *S. Infantis* (40.9%), *S. Enteritidis* (29.5%), and *S. Paratyphi B* (8.6%) were the greatest prevalent serotype. Totally 59.1% of the isolates were multidrug-unaffected by great resistance to nalidixic acid (67.6%), tetracycline (62.9%), and trimethoprim-sulfamethoxazole (42.3%) were saw (47).

5. Conclusions

Conducting regular epidemiological studies can be helpful to monitor the occurrence of *salmonella* cases and develop strategies to prevent this disease. The outcomes of this revision showed a high percentage of contamination in food samples in different provinces of Iran with different weather conditions and food culture.

Immethodical use of antibiotics does not reduce the overall percentage of food contamination with *Salmonella*, but also causes the antibiotic-resistant strains and their transmission to humans, financial costs and irreparable damage to the health of society.

simple and practical hygiene measures is recommended to prevent salmonellosis; such as well-done cooked animal products, washing hands after handling raw meat or unwashed vegetables, disinfection and cleaning of equipment and not consuming unpasteurized foods. Also, wider studies is recommended to determine the dimensions of this challenge and pay attention to the rational use of antibiotics.

Author contributions

M.S.D was responsible for the methodology, software, validation and formal analysis, visualization, E.M.A was responsible for conceptualization, methodology, edition and M.P was responsible for the investigation, resources, data curation, writing, editing, organization and project running.

Funding

Data accessibility statement

The collected data is based on the sources mentioned in the references section. These resources can be accessed by searching the databases, freely.

Acknowledgments

Conflicts of interest

The writers declare no conflicts of attention.

References

1. World Health Organization: Food safety and food borne illness. Geneva: WHO; 2007.

2. Newell DG, Koopmans M, Verhoef L, Duizer E, Aidara-Kane A, Sprong H, et al. Food-borne diseases—the challenges of 20 years ago still persist while new ones continue to emerge. Int. J. Food Microbiol. 2010; 139:S3-15.

3. Baldursson S, Karanis P. Waterborne transmission of protozoan parasites: review of worldwide outbreaks–an update 2004–2010. Water Res. 2011; 45(20):6603-14.

4. Asl HM, Gouya MM, Soltan-Dallal MM, Aghili N. Surveillance for foodborne disease outbreaks in Iran, 2006-2011. Med. J. Islam. Repub. Iran. 2015; 29:285.

5. McDonough PL. Salmonellosis: diagnostic approach to disease control and epidemiology in the bovine animal. In American association of bovine practitioners conference proceedings 1994;61-68.

6. Heinitz ML, Johnson JM. The incidence of *Listeria* spp., *Salmonella* spp., and *Clostridium botulinum* in smoked fish and shellfish. J. Food Prot. 1998; 61(3):318-23.

7. Steven L. Percival, David W. Williams. Microbiol. Waterborne Dis. Second Edition. Elsevier; 2014.

8. Jamshidi AE, Basami M, Afshari NS. Identification of *Salmonella* spp and *Salmonella typhimurium* by a multiplex PCR-based assay from poultry carcasses in Mashhad-Iran. Int. J. Vet. Res. 2009; 3(1):43-48.

9. The centers for disease control and prevention: *Salmonella*. United States: CDC; 2024.

10. The center for diseases control and prevention: *Salmonella typhi* outbreak information. United States: CDC; 2022.

11. Rezaee R, Mohammadi S, Faizee S. A study of *salmonella* spp. contamination of eggs in Sanandaj in 2017. Zanko J. Med. Sci. 2018; 19(61):43-9.

12. Soltan-Dallal MM, Yahyavi Firozabadi A, Sedighi khavidak S. Molecular epidemiology of *salmonella* food

outbreaks using culture and PCR in Yazd province. Razi J. Med. Sci. 2016; 23 (144): 1-8.

13. Moradi Bidhendi S. A review of studies on isolation, diagnosis and antimicrobial resistance of Salmonella in Iran. Vet. J. (Pajouhesh & Sazandegi). 2015; 28 (4): 21-30.

14. Heidarzadi MA, Rahnama M, Alipoureskandani M, Saadati D, Afsharimoghadam A. *Salmonella* and *Escherichia coli* contamination in samosas presented in Sistan and Baluchestan province and antibiotic resistance of isolates. Food Hyg. 2021; 11(2):42.

15. Azizpour A. Prevalence and antibiotic resistance of *Salmonella* serotypes in chicken meat of Ardabil, Northwestern Iran. Iran. J. Med. Microbiol. 2021; 15(2):232-46.

16. Rostami F, Rahimi E, Yahaghi E, Khodaverdi Darian E, Bagheri Moghadam M. Isolation and evaluation virulence factors of *Salmonella typhimurium* and *Salmonella enteritidis* in milk and dairy products. Iran. J. Med. Microbiol. 2014; 8(1):54-61.

17. Kazemeini H. Molecular detection of *Campylobacter* species and *Salmonella* spp in cattle raw milk specimens in Mazandaran province. J. Food Sci. Technol. (Iran). 2022; 19(125):101-8.

18. Sirdani A, Rajabi Z, Fardsanei F, Vahedi S, Soltan Dallal MM. Serogroup and antibiotic resistance pattern determination of *Salmonella* isolates from food. J. Gorgan Univ. Med. Sci. 2019; 21(4):114-20.

19. Alizadeh S, Momtaz H, Rahimi E. Isolation of *Salmonella typhimurium* and *Salmonella enteritidis* in bison milk and dairy products and bison meat by cultural and PCR method. J. Food Microbiol. 2018; 5(3):49-55.

20. Kalantary R, Mahdavi S. Isolation and molecular identification of *Salmonella* spp from local dairy products in Maragheh city in 2015 (Iran). Qom Univ. Med. Sci. J. 2017; 11(10):99-105.

21. Soltan Dallal MM, Poormoradian M, Asadpour S. The frequency of *Salmonella* serotypes in pasteurized and unpasteurized creams offered in local markets and their antibiotic resistance patterns. J. Sch. Public Health Inst. Public Health Res. 2020; 17(4):351-62.

22. Sana MJ, Siahi ZH. The determination of total microbial count and prevalence of *Salmonella* in the shrimp supply in Khuzestan province. Iran. J. Health Environ. 2018; 11(2):149-156.

23. Soltan Dallal M M, Emadi Koochak H, Sharifi Yazdi M K, Taheri Mirghaed A, Choobineh H. Determination of *Yersinia* Spp and *Salmonella Paratyphi B* isolated from possibly contaminated cream samples in the city of Tehran. Payavard. 2014; 8 (1) :34-43

24. Karimi DH, Esmailneshad F, Ebrahimi MK. Contamination of fresh beef to *Salmonella typhimurium* and *Salmonella enteritidis* in Sanandaj during 2012. J. Food Hyg. 2012 ;(7):41-49.

25. Besharati S, Owlia P, Sadeghi A, Ahmadi F, Fani F, Puladfar G, et al. Frequency, antibiotic resistance, and serogroups of *Salmonella* among chicken meat specimens in Tehran, Iran. Daneshvar Med. 2020; 27(4):1-0.

26. Hosseinpour M, Sabokbar A, Bakhtiari A, Parsa S. Comparison of bacterial culture, ELISA and PCR techniques for detection of *salmonella* in poultry meat samples collected from Tehran. J. Microb. World. 2013; 6(1):62-67.

27. Soltan Dallal MM, Heydari MR, Sharifi Yazdi MK, Mossadegh MH. The prevalence of *Salmonella* and *Bacillus* cereus contamination from pudding and sesame pudding produced by traditional methods in Yazd province of Iran. Pejouhandeh. 2016; 21(2):80-86.

28. Kaseb F, Shiranian M, Abdar M, Aminalroayaei H, Fallahzadeh H. The prevalence of *Salmonella* and *Staphylococcus aureus* in industrial Olivier salad in Yazd in 2013. Bimon. Sci. Res. J. Yazd Sch. Health. 2015; 14(3):51-59.

29. Doulat A, Mahzounieh MR, Shams N, Etemdfar L. Prevalence and comparison of *Salmonella* serotypes in indigenous and industrial chicken eggs collected from Khorramabad using culture and PCR methods. Iran. J. Med. Microbiol. 2018; 12(2):88-95.

30. Tajbakhsh E, Moumeni M. Detection of *staphylococcus areus* and *salmonella typimurium* in traditional and industrial olivie salads in shahrekord city. J. Food Microbiol. 2015; 2(1):39-48.

31. Amirmozaffari N, Rahmani Z, Iesazadeh Kh. Evaluation of the level of contamination with Salmonella spp in red meat, chicken, and domestic and industrial eggs produced in Talesh city and assessment of their antibiotic resistance pattern, Iran. Qom Univ. Med. Sci. J. 2013; 7(5):60-65.

32. Hamzeh Pour S, Vaziri S, Molaee Aghaee E. Survey on the contamination rate and determination of antibiotic resistance of *Staphylococcus aureus*, *Escherichia coli* and *Salmonella* strains isolated from traditional cheeses distributed in Mahabad, Iran. Iran. J. Health Environ. 2019; 11(4):465-76.

33. Khammar F, Alipour Askndany M, Saadati D. Study of *Salmonella* contamination of traditional ice creams in Zabol City, Iran. Iran. J. Med. Microbiol. 2017; 11(1): 83-89.

34. Mohamdzadehkhalkhali R, Fardin M, Sabzi A, Farshadi F, Abri R. Evaluation of the microbial quality of traditional ice creams offered in East Azarbaijan province. Comp. Pathobiol. 2020; 17(4)3349-3354.

35. Salehzadeh H, Rezaee R, Mozafari PA, Mohammadi S, Rezaee H. Investigation of bacterial contamination level of raw sweets in Sanandaj city in 2018. Beyhagh. 2018; 23(1):41-9.

36. Shohreh P, Azizkhani M, Tooryan F. Food poisoning bacteria from commercially important fish species collected from markets in Mazandaran province. Fish. Sci. Technol. 2019; 8(1):1-6.

37. Hajimohammadi B, Bagheri M, Zandi H, Dehghani A, Oryan A, Khalatbari-Limaki S, et al. Determination of bacterial contamination of the retail liver in butchers of Yazd city. J. Toloo-e-Behdasht. 2013; 15(5):1-10.

38. Anvarinezhad M, , Mirzaei H. Studying the amount of microbial contamination of traditional ice creams produced and sold in Maragheh city in 2013. Food Hyg. 2014; 3(11)75-82.

39. Dadmehr A, Sadighara P, Zeinali T. A study on microbial and chemical characterization of mechanically deboned chicken in Tehran, Iran. Int. J. Environ. Health Res. 2022; 32(11):2396-405.

40. Ghoddusi A, Nayeri Fasaei B, Zahraei Salehi T, Akbarein H. Serotype distribution and antimicrobial resistance of *Salmonella* isolates in human, chicken, and cattle in Iran. Arch. Razi Inst. 2019; 74(3):259-66.

41. Rahimi Z, Ghajarbeygi P, Mahmoud R, Mosavi S, Mehrabi A. Prevalence of *Salmonella* strains isolated from industrial quail eggs and local duck eggs, Iran. Carpathian J. Food Sci. Technol. 2022; 14(2): 165-174.

42. Dallal MM, Sharifi Yazdi MK, Mirzaei N, Kalantar E. Prevalence of *Salmonella* spp in packed and unpacked red meat and chicken in south of Tehran. Jundishapur J. Microbiol. 2014; 7(4): 1-4.

43. Moosavy MH, Esmaeili S, Bagheri-Amiri F, Mostafavi E, Zahraei-Salehi T. Detection of *Salmonella* spp in commercial eggs in Iran. Iran. J. Microbiol. 2015; 7(1):50-54.

44. Jeddi MZ, Yunesian M, Gorji ME, Noori N, Pourmand MR, Khaniki GR. Microbial evaluation of fresh, minimally-processed vegetables and bagged sprouts from chain supermarkets. J. Health Popul. Nutr. 2014; 32(3):391-399.

45. Mir R, Salari S, Najimi M, Rashki A. Determination of frequency, multiple antibiotic resistance index and resistotype of *Salmonella* spp in chicken meat collected from southeast of Iran. Vet. Med. Sci. 2022; 8(1):229-36.

46. Hosseininezhad B, Berizi E, Nader M, Mazloomi SM, Hosseinzadeh S, Ebrahimi L, et al. Prevalence of *Salmonella* contamination in consumed eggs in Iran: A systematic review and meta-analysis study on published studies from 1996 to 2018. Vet. World. 2020; 13(12):2744-2751.

47. Manzari M, Fani F, Alebouyeh M, Moaddeli A, Farzami MR, Shahidi MA, et al. Multidrug-resistant *Salmonella* strains from food animals as a potential source for human infection in Iran. Comparative Immunology. Microbiol. Infect. Dis. 2022; 90-91:1-9.