Prevalence and epidemiology of Salmonella enterica serovar Gallinarum from poultry in some parts of Haryana, India

Devan Arora¹, Suresh Kumar², Naresh Jindal¹, Gulshan Narang¹, P. K. Kapoor² and N. K. Mahajan¹

1. Department of Veterinary Public Health & Epidemiology, College of Veterinary Sciences, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar- 125 004, Haryana, India; 2. Department of Veterinary Public Health & Epidemiology, Disease Free Small Animal House, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana- 125004, India.

Corresponding author: Devan Arora, e-mail: devanarora7@gmail.com, SK: sureshkumar.hau@gmail.com, NJ: nareshjindal1@gmail.com, GN: gulshan.narang@gmail.com, PKK: drpkkapoor@gmail.com, NKM: mahajan448@rediffmail.com

Received: 23-06-2015, Revised: 15-09-2015, Accepted: 28-09-2015, Published online: 14-11-2015

doi: 10.14202/vetworld.2015.1300-1304 How to cite this article: Arora D, Kumar S, Jindal N, Narang G, Kapoor PK, Mahajan NK (2015) Prevalence and epidemiology of Salmonella enterica serovar Gallinarum from poultry in some parts of Haryana, India, Veterinary World 8(11):1300-1304.

Abstract

Aim: The present study was investigated to ascertain the epidemiological status of fowl typhoid (FT) in broilers in some parts of Haryana during January 2011 to December 2013.

Materials and Methods: To elucidate the epidemiological status of FT in broiler chickens for the 3 years (2011-2013) and to study the prevalence of various Salmonella serovars in poultry on the basis of culture characteristics, biochemical features, serotyping, and their antibiogram profile from some parts of Haryana (India). 

Results: A total of 309 outbreaks of FT were recorded in chickens during this period. Overall percent morbidity, mortality, case-fatality rate (CFR) in broiler chicks due to FT during this period was 9.45, 6.77, and 71.55. The yearly observations were divided into quarters A (January-March), B (April-June), C (July-September) and D (October-December). Maximum number of outbreaks - 106 (34.3%) was recorded in quarter D followed by quarters B - 84 (27.3%), C - 64 (20.7%), and A - 55 (17.7%). Salmonella isolates (253) were recovered from disease outbreaks in broilers from different parts of Haryana. Typical morphology and colony characters on MacConkeys Lactose Agar and Brilliant Green agar, biochemical reactions, serotyping along with antibiogram profiles were able to group these isolates into 3 groups namely Salmonella Gallinarum (183), Salmonella Enteritidis (41) and Salmonella Typhimurium (29). The antibiogram pattern of 183 isolates of S. Gallinarum revealed that most of the isolates were sensitive to gentamicin (76%) followed by amikacin (72%), kanamycin (71%).

Conclusion: FT is prevalent in commercial broiler flocks in different parts of Haryana and is responsible for considerably high morbidity and mortality in affected flocks. Isolation of S. Gallinarum (9, 12:183) from FT cases suggest it to be the primary pathogen, however, isolation of S. Typhimurium and S. Enteritidis from these cases is a major concern. The detection of S. Enteritidis and S. Typhimurium from FT cases assumes significance from public health point of view.

Keywords: antibiogram, salmonella gallinarum, serotyping.

Introduction

Salmonella enterica serovar Gallinarum (SG), the causative agent of fowl typhoid (FT) is an acute septicaemic disease of chickens and other galliforme birds [1]. The epidemiology of FT and Pullorum disease caused by S. Gallinarum and Salmonella Pullorum, respectively in poultry are known to be closely associated with infected poultry eggs, particularly with regard to its transmission from one generation to another. These are the leading causes of morbidity and mortality in commercial poultry and are responsible for significant economic losses to the poultry farmers [2]. Although, there are 2541 known serovars of Salmonella but in India, Salmonella Typhimurium and Salmonella Enteritidis are the two most common serotypes identified in reported cases of salmonellosis from different sources [3].

Over the years, the incidence of human infection and food poisoning by Salmonella has increased dramatically in Europe, USA and other parts of the world. Poultry and poultry products are the major source of infection [4].

S. Gallinarum infection in India became prominent when it was recorded as the commonest Salmonella of avian origin at the National Salmonella Centre at Indian Veterinary Research Institute, Izatnagar. This organism has been isolated from FT affected cases from almost all the states of India [5-7].

95 isolates of S. Enterica belonging to S. Gallinarum, S. Enteritidis, S. Typhimurium, S. Bareilly and S. Paratyphi B were reported with an overall prevalence rate of 14.40% from the North eastern region of India [8]. The prevalence of salmonellosis was studied in Karnataka, Maharashtra and Tamil Nadu and the most predominant serotype was S. Gallinarum in 69.6% followed by S. Enteritidis (21.7%) [5].

Realizing its wide prevalence, the present investigation was undertaken to elucidate the...
epidemiological status of FT in broiler chickens for the 3 years (2011-2013) and to study the prevalence of various *Salmonella* serovars in poultry on the basis of culture characteristics, biochemical features, serotyping and their antibiogram profile from some parts of Haryana (India).

**Materials and methods**

**Ethical approval**

The study was conducted after prior permission and approval from Institutional Animal Ethics Committee (IAEC), Lala Lajpat Rai University of Veterinary and Animal Sciences (LUVAS), Hisar.

**Study area**

The study was conducted mainly in six western and central region of Haryana, i.e., Hisar and adjoining districts (Sirsa, Fatehabad, Rohtak, Bhiwani and Jind).

**Recording of FT outbreaks**

Epidemiological data related to FT in poultry during the period 2011-2013 were obtained from the Disease Investigation Laboratory, Department of Veterinary Public Health and Epidemiology, College of Veterinary Sciences, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar. Variables taken into consideration for epidemiological studies were morbidity, mortality, case-fatality and a number of outbreaks. Quarter-wise and year-wise incidence in relation to the epidemiological indices of FT was calculated. The history of each flock was recorded. Gross pathological changes were also recorded.

**Isolation of *Salmonella* strains**

Isolation of *Salmonella* was attempted from commercial broiler chickens flocks (309) suspected to be suffering from FT. The disease was presumptively diagnosed as FT on the basis of clinical signs such as sudden death, huddling, diarrhea, dullness, ruffled feathers, and gross pathological changes such as necrotic foci on the liver, mottled spleen, and enteritis.

Briefly, samples of heart blood, liver and bile were collected aseptically and impression smears were streaked on MacConkeys Lactose Agar (MLA, Hi-media) and brilliant green agar (BGA, Hi-media) plates and kept at 37°C for 24 h. After incubation, bacterial colony from each plate was subjected to Gram’s staining. Organisms giving smooth, pinpoint, pale transparent colonies (non-lactose fermenter) on MLA were further streaked on BGA (Hi-media) plates and after 24 h of incubation showed typical small, smooth, dew drop like colonies with a pink background on BGA. Culture characteristics on MLA and BGA were used for initial identification of *Salmonella* [9]. These colonies were further subjected to biochemical tests as described by Mac-Faddin [10]. From each flock, only one colony was picked up for further testing.

**Identification of *Salmonella* isolates and serotyping**

Growth characteristics, morphology and motility characteristics of the *Salmonella* isolates were studied. Different biochemical tests, such as indole, methyl red, citrate, Voges–Proskauer, nitrate reduction, and carbohydrate fermentation tests, were carried out for the characterization of the organism. Carbohydrate fermentation tests included fermentation of glucose, lactose, arabinose, mannitol, and dulcitol [11]. Based on biochemical characterization, the isolates were confirmed as *Salmonella* and were maintained in the maintenance medium at 4°C for further study. Serotyping of the isolates was got done from the National *Escherichia* and *Salmonella* Centre, Kasauli, Solan (Himachal Pradesh), India.

**In-vitro antimicrobial sensitivity**

*In-vitro* susceptibility of 183 isolates of *S. Gallinarum* organisms (based on serotyping results) to various antimicrobial agents was determined by the disc diffusion method [12] on Mueller-Hinton agar plates (Hi-media). 16 antibiotic discs (Hi-media) of standard concentrations namely amikacin (30 mcg), ampicillin (10 mcg), ampicillin–sulbactam (10 mcg), co-trimoxazole (25 mcg), ciprofloxacin (5mcg), chloramphenicol (30 mcg), cefotaxime (30 mcg), ceftiraxone (10 mcg), enrofloxacin (5 mcg), ceftriaxone (100 mcg), gentamicin (10 mcg), nalidixic acid (30 mcg), norfloxacine (10 mcg), spectinomycin (100 mcg), tetracycline (30 mcg), sulfafurazole (300 mcg), kanamycin (30 mcg), and gentamicin (10 mcg) were used. The plates were incubated at 37°C for 24 h. Results were recorded using antibiotic zone scale and interpreted as sensitive (S), and resistant (R) based on values given in zone size interpretative chart (Hi-media, India).

**Results**

During 3-year period (2011-2013), a total of 309 (2.70%) flocks out of 11404 flocks brought for disease investigation, were affected with FT. The epidemiology of FT with respect to different variables like percent morbidity, mortality and CFR in broiler chicks during 2011-2013 have been presented in Table-1.

Overall percent morbidity, mortality, CFR in broiler chicks due to FT during the 3-year period was 9.45, 6.77 and 71.55, respectively. Percent morbidity due to FT was significantly higher during the years 2011 and 2012 as compared to the year 2013. Likewise, percent mortality was significantly higher in the year 2012 as compared to that in 2013. In contrast, CFR was significantly higher during the years 2012 and 2013 than that in 2011.

**Quarter-wise distribution of FT**

Quarter-wise distribution of FT in relation to percent morbidity, mortality, CFR and number of outbreaks during the period from 2011 to 2013 has been shown in Table-2.

A maximum number of outbreaks (106) were recorded in quarter D followed by quarters B (84), C (64) and A (55). Percent morbidity and mortality in quarter C were significantly lower than quarters.
B and D. Though these indices were also lower in quarter C as compared to quarter A; the difference for percent mortality was not statistically significant. The CFR in quarters B, C and D was significantly higher than that in quarter A.

**Serotyping and in vitro antimicrobial sensitivity**

Serotyping of 253 (Table-3) *Salmonella* isolates revealed that *S. Gallinarum* was the most prevalent (183 isolates; 69.62%) organism from FT affected birds followed by *S. Enteritidis* (41 isolates; 16.45%) and *S. Typhimurium* (29 isolates; 13.92%). The antigenic structure of *S. Gallinarum* was 9,12:-:-- while that of *S. Enteritidis* and *S. Typhimurium* were 9,12: g, m:- and 4,12: 1:1, 2, respectively. The prevalence of *S. Enteritidis* and *S. Typhimurium* from FT cases assumes significance from public health point of view. The antibiogram pattern (Table-4) of the 183 isolates of *S. Gallinarum* revealed that most of the isolates were sensitive to gentamicin (76%) followed by amikacin (72%), kanamycin (71%), chloramphenicol (71%) and streptomycin (70%).

**Discussion**

Control of FT is difficult due to the endemicity of the disease [13], facultative intracellular nature of the organism, both vertical [14] and horizontal [15] modes of transmission, multiple drug resistance and presence of carrier stage. The indiscriminate and widespread use of antibiotics in the treatment of poultry diseases has lead to increase in the number of resistant *Salmonella* strains isolated [16]. Antimicrobial resistance is nowadays a global public health concern [17]. FT caused by *S. Enterica* SG is one of the most important bacterial diseases of poultry. This disease occurs more often in acute form in young chicks and mortality is encountered most frequently during first 2 weeks of age. A total of 309 outbreaks of FT were recorded in the present study with percent morbidity and mortality of 9.45 and 6.77, respectively in 3-year period. Overall CFR due to FT in these outbreaks during the 3-year period was 71.55% (Table-1). 198 outbreaks were recorded of FT in commercial broiler chicks during the period from 1987-1990 with percent mortality of 10.54%[18]. Likewise, during the period from July 1996-June 1997 recorded 39 outbreaks of FT with overall morbidity and mortality of 14.22 and 12.12%, respectively[19]. A total of 23 *Salmonella* isolates were recovered from different disease outbreaks in different geographical locations of Karnataka,

**Table-1:** Year wise percent morbidity, mortality, case fatality rate due to FT in broiler chicks in some parts of Haryana during 2011-2013.

| Year | Total number of flocks affected | Total number of flocks affected with FT (%) | Morbidity (%) | Mortality (%) | Case fatality rate (%) |
|------|---------------------------------|---------------------------------------------|---------------|--------------|------------------------|
| 2011 | 4578                            | 117 (2.55)                                  | 10.14         | 6.42         | 63.32                  |
| 2012 | 3805                            | 121 (3.18)                                  | 10.97         | 8.37         | 76.32                  |
| 2013 | 3021                            | 71 (2.35)                                   | 7.06          | 5.35         | 75.80                  |
| Total| 11404                           | 309 (2.70)                                  | 9.45          | 6.77         | 71.55                  |

Means with different superscript in a column for a parameter differ significantly (p \( \leq 0.05 \)), FT=Fowl typhoid

**Table-2:** Quarter wise distribution of percent morbidity, mortality, case fatality rate due to FT in broiler chicks in some parts of Haryana during 2011-2013.

| Quarter | Total number of flocks affected (%) | Morbidity (%) | Mortality (%) | Case fatality rate (%) |
|---------|-------------------------------------|---------------|--------------|------------------------|
| A       | 55 (17.7)                           | 10.28         | 6.24         | 60.75±9.61             |
| B       | 84 (27.3)                           | 10.25         | 7.50         | 73.19±4.30             |
| C       | 64 (20.7)                           | 6.87          | 4.84         | 70.37±3.57             |
| D       | 106 (34.3)                          | 10.17         | 7.77         | 76.61±2.14             |
| Total   | 309                                 | 9.45          | 6.77         | 71.55                  |

A=January-March, B=April-June, C=July-Sept., D=October-December, means with different superscript in a column differ significantly (p≤0.05), FT=Fowl typhoid

**Table-3:** Distribution of different serotypes of *Salmonella* isolated from poultry from some parts of Haryana.

| Serotypes | Number isolated | Relative occurrence (%) | Antigenic structure |
|-----------|-----------------|-------------------------|--------------------|
| *S. Gallinarum* | 183 | 69.62 | 9,12:-:-- |
| *S. Enteritidis* | 41 | 16.45 | 9,12: g, m:- |
| *S. Typhimurium* | 29 | 13.92 | 4,12: 1:1, 2 |
| Total | 253 | - | - |

**Table-4:** In-vitro antimicrobial drug sensitivity (%) pattern of *S. Gallinarum* isolated from FT cases during the year 2011-2013.

| Drug | Sensitive* (%) |
|------|----------------|
| Gentamicin | 139 (76) |
| Amikacin | 132 (72) |
| Kanamycin | 130 (71) |
| Chloramphenicol | 130 (71) |
| Streptomycin | 128 (70) |
| Co-Trimoxazole | 126 (69) |
| Amoxy-Clav | 126 (69) |
| Sulfafurazole | 124 (68) |
| Ampicillin | 122 (67) |
| Enrofloxacin | 120 (66) |
| Ampicillin-Sulbactam | 120 (66) |
| Cefoperazone | 110 (60) |
| Norfloxacin | 51 (28) |
| Tetracycline | 38 (21) |
| Ciprofloxacin | 37 (20) |
| Carbenicillin | 37 (20) |
| Ceftriaxone | 31 (17) |
| Cefotaxime | 27 (15) |
| Nalidixic acid | 22 (12) |

Total isolates of *S. Gallinarum* tested=183, FT=Fowl typhoid, *S. Gallinarum=* *Salmonella* Gallinarum
procured from hatchery that is free from improper management may lead to higher mortality in chicks in this region. Extreme weather conditions and industry [20]. Being vertically transmitted disease, particularly in December thereby causing stress on birds and making birds more susceptible to disease.

Vertical transmission of infection from breeding hens to progeny is an important aspect of the epidemiology of Salmonella spp. infection within the poultry industry [20]. Being vertically transmitted disease, most FT outbreaks are recorded in young broiler chicks in this region. Extreme weather conditions and improper management may lead to higher mortality in chicks. Hence, it is important that the chicks should be procured from hatchery that is free from Salmonella.

The results of serotyping revealed increased the prevalence of S. Gallinarum than S. Enteritidis and S. Typhimurium in FT affected birds in this region (Table-3). S. Gallinarum, the causative agent of FT, is the most prevalent host adapted Salmonella strain of poultry in India [21]. S. enterica SG infections have been reported from time to time in many parts of the world by various workers notably from Canada[22] and from England [23].

Many workers also reported more isolations of S. Gallinarum than S. Enteritidis from poultry and S. Enteritidis or S. Typhimurium in addition to S. Gallinarum have been also isolated from FT affected birds from abroad [24,25]. The detection of S. Enteritidis and S. Typhimurium from FT cases assumes significance from public health point of view [26,27].

The antibiogram of 183 isolates of SG revealed that most of the isolates were sensitive to gentamicin followed by amikacin, kanamycin and chloramphenicol, the pattern was more or less in accordance with the findings of [3,28]. Above all, maximum resistance was obtained against nalidixic acid followed by carbenicillin [29]. A study also showed a high prevalence of nalidixic acid resistance among Salmonella isolates [30]. It is surprising to note that SG isolates were resistant to nalidixic acid whose use in poultry feed as feed additive or for treatment purposes seems to be rare in this region. Development of resistance by the organisms to other antimicrobials could be due to their indiscriminate use in feed as additives or for treatment purposes [31]. Hence, there is a need to educate farmers that the antimicrobials should be used judiciously, and indiscriminate use should be discouraged.

Conclusions

FT is prevalent in commercial broiler flocks in different parts of Haryana and is responsible for considerably high morbidity and mortality in affected flocks. Isolation of S. Gallinarum (9, 12:-:-) from FT cases suggest it to be the primary pathogen, however, isolation of S. Typhimurium and S. Enteritidis from these cases is a major concern. The majority of isolates were resistant to nalidixic acid and carbenicillin while most sensitive antibiotics were gentamicin, amikacin and kanamycin. Surveillance, identification and antibiotic sensitivity of the prevalent Salmonella serotypes in the country would help devise suitable prevention and control program for this important poultry pathogen. Since the consumption of poultry products is often associated with salmonellosis, therefore, it becomes necessary to update information about Salmonella resistance to antibiotics used in poultry production.

Authors’ Contributions

DA and SK participated in the epidemiological studies. NJ and GN collected bacterial isolates. PKK, NKM carried out biochemical characterization and ABST. All authors contributed in drafting and revision of the manuscript. All authors read and approved the final manuscript.

Acknowledgments

The authors express their gratitude to the Dean, College of Veterinary Science, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana for providing the facilities and fund. Authors are also thankful to the staff of Department of Veterinary Public and Health and Epidemiology, College of Veterinary Science, LUVAS, Hisar.

Competing Interests

The authors declare that they have no competing interests.

References

1. Priyantha, M.A.R. (2009) An overview: Vaccination to control fowl typhoid in commercial layers, Sri Lanka. Wayamba J. Anim. Sci., 1: 23-25.
2. Kumar, T., Mahajan, N.K. and Rakha, N.K. (2010) Epidemiology of fowl typhoid in Haryana, India. World Poult. Sci., J., 66: 503-509.
3. Selvaraj, R., Das, R., Ganguly, S., Ganguli, M., Dhanalakshmi, S. and Mukhopadhayay, S.K. (2010) Characterization and antibiogram of Salmonella spp. from poultry specimens. J. Microbiol.Antimicrobiol., 2(9): 123-126.
4. EFSA. (2007) European Food Safety Authority. EU-wide survey on Salmonella levels in broilers. Available from: http://www.efsa.europa.eu/en/press_room/press_release/pr_zoon_Salmonella_broilers.html. Accessed on 28-05-2015.
5. Prakash, B., Krishnappa, G., Muniyappa, L. and Kumar, B.S. (2005) Epidemiological characterization of avian Salmonella Enterica serovar infections in India. Int. J. Poult. Sci., 4(6): 388-395.
6. Kumari, D., Mishra, S.K. and Lather, D. (2013) Pathomicrobial studies on *Salmonella Gallinarum* infection in broiler chickens. *Vet. World*, 6(10): 725-729.

7. Mishra, P. and Shukla, S. (2014) Identification and sensitivity to antimicrobial agents of *Salmonella* isolated from poultry carcass. *Int. J. Anim. Vet. Fish. Allied Sci.*, 1(1): 34-40.

8. Murungkar, H.V., Rahman, H., Kumar, A. and Bhattacharya, D. (2005) Isolation, phage typing and antibiogram of *Salmonella* from man and animals in northeastern India. *Indian J. Med. Res.*, 122: 237-242.

9. Cowan, S.T. (1974) Cowan and Steel’s *Manual for the Identification of Medical Bacteria*. 3rd ed. Cambridge University Press, Cambridge. p97-164.

10. Mac-Faddin, J.F. (1976) *Biochemical Test for Identification of Medical Bacteria*. Williams and Wilkins, Baltimore.

11. Edwards, P.R. and Ewing, W.H. (1972) Identification of Enterobacteriaceae. Burgess Publishing Co., Minneapolis.

12. Bauer, A.W., Kirby, W.M.M., Sherris, J.C. and Truck, M. (1966) Antibiotic susceptibility testing by standardizing single disc method. *Am. J. Clin. Pathol.*, 45: 493.

13. Soncine, R.A. and Back, A. (2001) *Salmonella Enteritidis* in birds: eradication or control vaccine. In: Apinco Conference of Poultry Science and Technology. Vol. 1. Campinas. FACTA, Anais, Sao Paulo. p21-30.

14. Paiva, J.B., Penna, A., Anguolo, Y.M.S., Siva, M.D., Gardin, Y., Resende, F., Berchieri, A. and Sestsi, L. (2009). Efficacy of several *Salmonella* vaccination programmes against experimental challenge with *Salmonella Gallinarum* in commercial brown breeder hens. *Braz. J. Poult. Sci.*, 11(1): 65-72.

15. Cox, N.A., Bailey, J.S. and Berrang, M.E. (1996) Extent of *Salmonella* contamination in breeder hatcheries. *Poult. Sci.*, 70: 416-418.

16. Enabulele, S.A., Amune, P.O. and Aborisade, W.T. (2010) Antibiograms of *Salmonella* isolates from poultry in Ovia North East local government area Edo State, Nigeria. *Agric. Biol. J. N. Am.*, 1(6): 1287-1290.

17. Ahmed, M.M., Rahman, M.M., Mahbub, K.R. and Wahiduzzaman, M. (2011) Characterization of antibiotic resistant *Salmonella* spp. isolated from chicken eggs of Dhaka city. *J. Sci. Res.*, 3(3): 191-196.

18. Mahajan, N.K., Jindal, N. and Kulshrestha, R.C. (1994) Major broiler diseases in some parts of Haryana. *Indian J. Anim. Sci.*, 64: 1118-1122.

19. Jindal, N., Rana, N., Kumar, S., Narang, G. and Mahajan, N.K. (1999) *Salmonella Gallinarum* and *Salmonella Enteritidis* infections in poultry in some parts of Haryana. *Indian Vet. J.*, 76: 563-564.

20. Dutta, P., Borah, M.K., Gangil, R. and Singgathia, R. (2015) Gross/ Histopathological impact of *Salmonella Gallinarum* isolated from layer chickens in Jaipur and their antibiogram assay. *Int. J. Adv. Vet. Sci. Technol.*, 4(1): 153-159.

21. Gupta, V., Ray, P. and Sharma, M. (1999) Antimicrobial resistance pattern of *Shigella* and nontyphi *Salmonella* isolated from patients with diarrhoea. *Indian J. Med. Res.*, 109: 43-45.

22. Glover, J.S. and Handerson, W. (1946) FT-Report of a record outbreak in Ontario. *Can. J. Comp. Med.*, 10: 241-249.

23. Smith, J.S. and Buxton, W. (1951) Isolation of *Salmonella* from faces of domestic animals. *Braz. Med. J.*, 1: 1479-1483.

24. Rahman, M.R., Shahinuzzaman, A.B.M., Saha, A.K., Sufian, M.A., Rahman, M.H. and Hossain, M.M. (2011) Prevalence of *Salmonella* infection in naturally infected layer birds in Bangladesh. *Bangladesh Vet.*, 28(1): 8-18.

25. Lee, S.K., Chon, J.W., Song, K.Y., Hyeon, J.Y., Moon, J.S. and Seo, K.H. (2013) Prevalence, characterization, and antimicrobial susceptibility of *Salmonella Gallinarum* isolated from eggs produced in conventional or organic farms in South Korea. *Poult. Sci.*, 92(10): 2790-2797.

26. Gong, J., Zhang, J., Xu, M., Zhu, C., Yu, Y., Liu, X., Kelly, P., Xu, B. and Wang, C. (2014) Prevalence and fimbrial genotype distribution of poultry *Salmonella* isolates in China (2006 to 2012). *Appl. Environ. Microbiol.*, 80(2): 687-693.

27. Landinez, P.M., Ungunza, S.R., Guard, J. and Nascimento, V.P. (2014) Presence of *Salmonella Enteritidis* and *Salmonella Gallinarum* in commercial laying hens diagnosed with fowl typhoid disease in Colombia. *Avian Dis.*, 58(1): 165-170.

28. Kumar, T., Mahajan, N.K. and Rakha, N.K. (2012) Isolation and prevalence of *Salmonella* serovars from poultry in different parts of Haryana, India. *Indian J. Anim. Sci.*, 82(6): 557-560.

29. Lee, Y.J., Kim, H.J., Park, C.K., Kim, K.S., Bae, D.H., Kang, M.S., Cho, J.K., Kim, A.R., Kim, J.W. and Kim, B.H. (2007) Characterization of *Salmonella* spp. isolated from an integrated broiler chicken operation in Korea. *J. Vet. Med. Sci.*, 69(4): 399-404.

30. Taddele, M.H., Rathore, R. and Dhama, K. (2012) Antibiogram assay of *Salmonella Gallinarum* and other *Salmonella* Enteric serovars of poultry origin in India. *Asian J. Anim. Vet. Adv.*, 7(4): 309-317.

31. Wei, L.S. and Wee, W. (2011) Antibiogram and heavy metal resistance pattern of *Salmonella* spp. isolated from wild Asian Sea Bass (*Lates calcalifer*) from Tok Bali, Kelantan, Malaysia. *Jordan J. Biol. Sci.*, 4(3): 125-128.