Malaysian Journal of Microbiology, Vol 10(3) 2014, pp. 219-224
http://dx.doi.org/10.21161/mjm.58213

Malaysian Journal of Microbiology
Published by Malaysian Society of Microbiology
(In SCOPUS since 2011)

SHORT COMMUNICATION

Occurrence of antibiotic resistant *Salmonella* isolated from dogs in Klang Valley, Malaysia

Mustapha Goni Abatcha[1], Zakaria Zunita[1*], Dhaliwal Kaur Gurmeet[2], and Kwai Lin Thong[3]

[1]Department of Pathology and Microbiology, Faculty of Veterinary Medicine, Universiti Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia.
[2]Department of Clinical Studies, Faculty of Veterinary Medicine, Universiti Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia.
[3]Institute of Biological Sciences, Faculty of Science, University of Malaya, 50603 Kuala Lumpur, Malaysia.
Email: zunita@vet.upm.edu.my

Received 26 September 2013; Received in revised form 13 January 2014; Accepted 3 February 2014

Aims: Salmonellosis continues to be a major public health concerned globally. The objective of the study was to determine the occurrence and antimicrobial resistance pattern in *Salmonella* isolated from non-diarrheic stray and pet dogs in Klang Valley, Malaysia.
Methodology and results: A total of 162 dogs were sampled, 15 (9.3%) were positive for *Salmonella* (stray dogs, n=12; pet dogs, n=3). All the isolates were identified as *Salmonella* using conventional culture methods and confirmed by PCR-targeting the *inv*A gene. Four different *Salmonella* serovars were identified upon serotyping including *Salmonella* Corvallis (53.3%), *S.* Typhimurium (13.3%), *S.* Mbandaka (20%), and *S.* Agona (6.7%). *Salmonella* isolates were resistant to tetracycline (86.7%), sulphamethazole-trimethoprim (40%), ampicillin (40%), chloramphenicol (33.3%), streptomycin (33.3%), and enrofloxacin (26.7%). None of the isolates was resistant to gentamycin, cephalexin and amoxicillin-clavulanic acid. Eight isolates (53.3%) were multiple drugs resistant.
Conclusion, significance and impact study: High number of canine *Salmonella* isolates developed resistance and this may likely be public health concern.

Keywords: Dogs, *Salmonella, inv*A genes, serotyping, antibiotic resistance.

INTRODUCTION

Salmonellosis is one of the most important zoonotic diseases with global distribution and importance (Sanchez *et al*., 2002). *Salmonella* is a common inhabitant of the intestinal tracts of a broad range of animal hosts, including mammals, reptiles, birds and even insects. Dogs have been reported to be a carrier of *Salmonella* spp. worldwide which has the potential to serve as sources of exposure or infection for humans (Filip *et al*., 2004). Many findings have indicated that *Salmonella* is uncommonly present in healthy dogs. The prevalence of *Salmonella* in household pet ranges between 0-2.9% and in stray dogs was 6.3-23.5% respectively (Hackett and Lappin 2003; Lefebvre *et al*., 2006; Bagcigil *et al*., 2007). The incidence of salmonellosis and intestinal carriage of *Salmonella* in pets and stray dogs is of important public health concern worldwide. There have been many reports on *Salmonella* shedding and transmission to humans (Sato *et al*., 2000; Cherry *et al*., 2004; Wright *et al*., 2005).

The increasing incidence of antibiotic resistant bacteria is also an important heath concern internationally, and animals are potential reservoirs for many resistant bacteria (Boerlin and Reid-Smith, 2008). Recent studies showed that close contact between humans and animals can lead to the exchange of pathogenic bacteria, including those carrying antibiotic resistant genes (Johnson *et al*., 2006). Multiple drug resistant strains of *Salmonella* serovars have being isolated from dogs (Guardabassi *et al*., 2004; Umber and Bender, 2009). These *Salmonella* serovars include Albany, Anatum, Havana, London and Typhimurium (Van *et al*., 2007). Resistance towards the first line of antibiotics such as ampicillin, chloramphenicol and trimethoprim-sulfamethoxazole are of concern because of the potential transfer to humans, limiting the options for chemotherapy in invasive salmonellosis (Crump and Mintz, 2010). The aim of the study was to determine the occurrence of antibiotic resistance in *Salmonella* in dogs in Klang Valley, Malaysia.

***Corresponding author**

ISSN (print): 1823-8262, ISSN (online): 2231-7538

MATERIALS AND METHODS

Source of samples

A total of 162 rectal swab samples from dogs of different age, sex, and breed were taken. Rectal swabs were collected from 75 pet dogs at a Veterinary Hospital, Universiti Putra Malaysia located in Selangor city and for 85 stray dogs were collected from a municipal animal shelter located Kuala Lumpur, Malaysia. The swabs were transported in Cary Blair transport medium to the laboratory within 24 h of collection.

Isolation and identification of *Salmonella*

The isolation of *Salmonella* from rectal was performed after selective enrichment in Rappaport-Vassiliadis-Soy peptone (Oxoid, UK) broth and incubated at 37 °C for 24 h. A loopful of enriched broth was streaked on Xylose-lysine desoxycholate (XLD) and Brillian green ager (BGA) (Oxoid, UK) agar plates and incubated at 37 °C for 24 h. All presumptive *Salmonella* colonies were subcultured onto nutrient agar (Oxoid, UK) at 37 °C for 24 h, and further confirmed by biochemical tests as recommended by the guidelines of the ISO 6579 (2002). These biochemical tests included the Triple Sugar Iron (TSI), Sulfide Indole Motility (SIM), Simmons citrate, and Urease test reactions. The Slide agglutination test as done on presumptive *Salmonella* isolates using a *Salmonella* polyvalent O antiserum (Gp A-S) test (Remel Europe, UK) to identify the organism as *Salmonella* spp. The *Salmonella* serotypes were determined using the Kauffmann-White classification scheme using a battery of somatic and flagellar antisera (OIE Terrestial Manual, 2008). The serotyping was done at the *Salmonella* Reference Centre at Veterinary Research Institute (VRI) Ipoh, Malaysia.

Polymerase chain reaction for *Salmonella* confirmation

DNA template for PCR was prepared by direct crude boiled cell lysate. The *Salmonella* genus specific primers, *inv*A gene were employed to confirm the identity of the isolates (Rahn *et al.*, 1992). The sequences for the primers are; Forward (5'-3'): GTG AAA TTA TCG CCA CGT TCG GGC AA and Reversed (5'-3'): TCA TCG CAC CGT CAA AGG AAC C). Amplification for the PCR was performed in 50 µL reaction volumes containing template (DNA) 5 µL; Top taq master mix 25 µL (Qiagen); 1x coral load 5 µL (Qiagen); *Inv*A primer forward and reverse 1 µL each and RNAse free water 13 µL (Qiagen). The reaction was conducted in Thermal cycler (Eppendorf) under the following cycling condition: An initial incubation 94 °C for 60 s, followed by 35 cycles of denaturation at 94 °C for 60 sec, annealing at 55 °C for 30 sec and elongation at 72 °C for 45 sec, followed by 7 min final extension period. The amplified DNA products were electrophoresed on 1.5% agarose gel for 45 min at 100 voltages. *Salmonella* Typhimurium ATCC 14028 use as the positive control while deionised water was used as the negative control. Then the gels stained with ethidium bromide and visualized by UV illumination. The DNA ladder used is 100 bp as a marker for products of the PCR.

Antibiotic susceptibility test

Susceptibility to antimicrobial agents was tested using the Kirby-bauer disk diffusion method on Muller-Hinton agar with commercial antibiotic disks (Oxoid Ltd, Basingstoke, UK) as recommended by Clinical and laboratory Standard Institute (CLSI, 2009). A total of 12 antimicrobials used included tetracycline (30 µL), streptomycin (25 µg), amoxicillin-clavulanic acid (30 µg), kanamycin (30 µg), ampicillin (10 µg), chloramphenicol (30 µg), sulphamethoxazole/trimethoprim (25 µg), gentamicin (10 µg), neomycin (10 µg), cephalexin (30 µg), cephalothin (30 µg), enrofloxacin (5 µg).

RESULTS AND DISCUSSION

Fifteen dogs (9.3%) were tested positive for the presence of *Salmonella*. All presumptive *Salmonella* isolates contained *inv*A gene by producing the 284 bp amplicon (Figure 1) confirming the identity of isolates as *Salmonella*. Of these *Salmonella*-positive dogs, 12 (14/87, 13.8%) were from stray dogs and 3 (5/75, 4.0%) were from pet household dogs. Upon serotyping, 4 serovars were identified including *Salmonella* Corvallis (53.3%), *Salmonella* Typhimurium (13.3%), *Salmonella* Mbandka (20%), and *Salmonella* Agona (6.7%). The remaining 6.7% of the isolates were untypable using the available antisera and regarded as *Salmonella* spp. (Table 1). Out of 15 *Salmonella* isolates, one was susceptible to all 12 antimicrobials tested, while the other 14 (66.7%) were resistant to at least one antimicrobial. Higher resistance rates were observed for tetracycline (86.7%) followed by sulphamethazole-trimethoprim (40%), ampicillin (40%), chloramphenicol (33.3%), streptomycin (33.3%), and enrofloxacin (26.7%). None of the isolates was resistant to gentamycin, cephalexin and amoxicillin-clavulanic acid (Table 2). Eight isolates exhibited multiple drug resistance (resistant to more than 3 classes of antibiotics) (Table 2).

The Multiple antibiotic resistant (MAR) Index of an isolate is defined as a/b, where a represents the number of antibiotics to which the isolate was resistant and b represents the number of antibiotics to which the isolate was tested (Krumperman, 1985). The MAR indexes of the isolates were calculated and noted in Table 2.

Salmonellosis constitutes a major public health burden and represents a significant cost to society in many countries. In this study, the overall incidence of *Salmonella* detected in dogs was 9.3%. The rate of *Salmonella* isolation is less from that reported in Thailand (12.4%) (Arunee *et al*., 2012), USA (20.8%) (Frye and Fedorka-Cray, 2007) but higher than that of Taiwan

 ISSN (print): 1823-8262, ISSN (online): 2231-7538

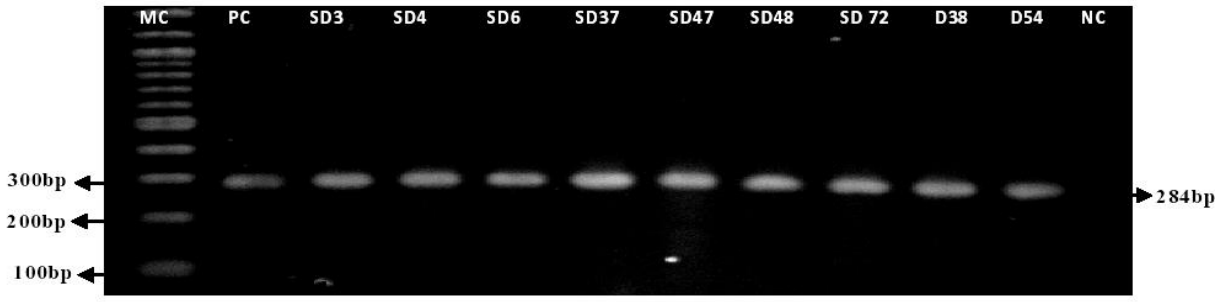

Figure 1: PCR amplification of *inv*A (284 bp) genes. Lane MC, Molecular ladder 100 bp, Lane PC, Positive control *Salmonella* Typhimurium ATCC 14028, Lane SD3, SD4, SD6, SD37, SD47, SD48, SD72, D38, D54 samples and lastly lane NC: Negative control.

Table 1: Antimicrobial resistance of *Salmonella* isolates from dogs.

Antibiotics	Resistance (%)
Ampicillin (AMP) 10 µg	6 (40)
Chloramphenicol (C) 30 µg	5 (33.3)
Gentamycin (CN) 120 µg	0 (0)
Kanamycin (K) 30 µg	2 (13.3)
Streptomycin (S) 25 µg	5 (33.3)
Neomycin (N) 10 µg	2 (13.3)
Cephalexin (CL) 30 µg	0 (0)
Cephalothin (KF) 30 µg	2 (13.3)
Enrofloxacin (ENR) 5 µg	4 (26.7)
Sulphamethazole-TriM (SxT) 25 µg	6 (40)
Tetracycline (TE) 30 µg	13 (86.7)
Amoxicillin-Clavulanic acid (AMC) 30 µg	0 (0)

Table 2: Antibiotic profile of different *Salmonella* serovars isolated from stray and pet dogs.

Isolate ID	Serovars	Antimicrobial resistance pattern	MAR index
*D54	Agona	C, K, N, ENR, S, AMP, SXT	0.6
*SD6	Corvallis	C, KF, AMP, SXT, TE	0.4
*SD47	Corvallis	C, KF, AMP, SXT, TE	0.4
*SD61	Typhimurium	C, KF, AMP, SXT, TE	0.4
*SD68	*Salmonella enterica*	C, K, N, AMP, SXT, TE	0.4
*SD63	Mbandaka	AMP, SXT, TE	0.3
*SD 37	Corvallis	ENR, S, TE	0.2
*SD72	Corvallis	ENR, S, TE	0.2
SD3	Corvallis	S, TE	-
D38	Mbandaka	S, TE	-
SD4	Corvallis	TE	-
SD64	Corvallis	TE	-
SD48	Corvallis	TE	-
SD57	Typhimurrium	TE	-

*MDR SD, Stray dog; D, Pet household dog

ISSN (print): 1823-8262, ISSN (online): 2231-7538

(4.3%) (Tsai *et al*., 2007), and Trinidad (3.6%) (Seepersadsingh *et al*., 2004).

The prevalence of *Salmonella* varied among different countries and this might be attributed to the sample size of dogs, sample origin, type of faecal sample, and isolation methods used in the different countries. Our study shows that stray dogs had higher *Salmonella* positive rate than household dogs. The diversity of diet source, free movement and environment of stray dogs apparently determine the number and occurrence of *Salmonella* serovars (Finley *et al*., 2007). All the serovars identified in this study have previously been found in humans, animals and food products (Ammari *et al*., 2009; Le Bouquin *et al*., 2010; Thong and Moderrasi, 2011). The serovars were *S.* Corvallis, *S.* Mbandaka, *S.* Typhimurium, *S.* Agona and *S.* enterica. This shows that *Salmonella* found in dogs may be related to human Salmonellosis. In Malaysia, *S.* Typhimurium, *S.* Corvalis and *S.* Agona are frequently incriminated in human illness (MOH, 2005), and *Salmonella* Mbandaka has been isolated in humans in Denmark (Torpdahl *et al*., 2009).

In this study, the invasion gene, *inv*A was detected in all *Salmonella* isolated. The *inv*A gene of *Salmonella* contains sequence unique to this genus and confirms the usefulnes of this target for PCR confirmation of *Salmonella* (Rahn *et al*., 1992; Jamshidi *et al.*, 2008). This finding closely agrees with other studies which reported the detection of this gene in almost all *Salmonella* isolates (Shanmugasamy *et al*., 2011; Tafida *et al.*, 2013).

In the past decade, the emergence of antimicrobial-resistant *Salmonella* has become a major public health problem. The present study demonstrated that 66.7% of the *Salmonella* isolates exhibited resistance to at least more than one antibiotic. Also a higher number of multidrug resistances were found among the *Salmonella,* being resistance to 3 or more groups of antimicrobial agents. Higher resistances rates are in tetracycline (86.7%) were found among the *Salmonella*. This finding was higher than those from Thailand 43.5% and Taiwan 38.8% of the *Salmonella* strains in dogs are resistant to tetracycline (Chang *et al*., 2011; Arunee *et al*., 2012). This probably due to drug being widely use in human and veterinary medicine and in animal feed as a growth promoter and addictive supplement (Cardoso *et al*., 2006). Notably high levels of resistance to sulphamethazole-trimethoprim (40%), ampicillin (40%), chloramphenicol (33.3%) and streptomycin (33.3%) were observed. These findings concurred with previous reports that *Salmonella* strains from dogs were resistant to multiple antimicrobials, including tetracycline, sulfonamides and streptomycine (Leonard *et al*., 2012). The most commonly observed MDR *Salmonella* serovars were *S.* Agona (D54), *S.* Corvallis (SD6, SD47), *S.* Typhimurium (SD61), *S. enterica* (SD68) and *S.* Mbandaka (63) (Table 2). However, continuous monitoring revealed the isolation frequency of MDR *Salmonella* in general sources is on increased worldwide (Frye and Fedorka-Cray, 2007). The MAR Index analysis reveals that 6 isolates had a very high MAR index value (> 0.2). Bacteria having MAR Index > 0.2 originate from an environment where several antibiotics are used (Tambekar *et al*., 2006). The broader range of MAR index observed from the *Salmonella* isolated from dogs might be due to antimicrobial use in veterinary treatment or feeds addictive. Likewise, none of *Salmonella* in this study is resistant to gentamycin, cephalexin, and amoxicillin-clavulanic acid. Finally, findings of the present study ascertain that *Salmonella* serovars in dogs have developed resistance for routinely prescribed antimicrobial drugs and pose considerable health risk to the public.

CONCLUSION

In conclusion, this study confirmed that the stray and pet dogs might act as reservoirs for *Salmonella* thereby serving as a source of human infection and a potential threat to public health. The occurrence of multiple antibiotic resistances in the *Salmonella* is worrisome as it could pose a risk to animal and human health. This finding provides a starting point for investigating the impact of antimicrobial resistance in Malaysian dogs

ACKNOWLEDGEMENT

The authors would like to thank the laboratory technicians and assistants at Bacteriology laboratory, staff at UVH, Faculty of Veterinary Medicine, Universiti Putra Malaysia, DBKL Malaysia, for their kind cooperation over the course of this study. We also like to thank RUGS 91848 for funding the research project and University of Malaya (grant 57-02-03-1015) for financial support.

REFERENCES

Ammari, S., Laglaoui, A., En-nanei, L., Bertrand, S. Wildemauwe, C., Barrijal S. and Abid, M. (2009). Isolation, drug resistance and molecular characterization of *Salmonella* isolates in Northern Morocco. *Journal of Infectious in Developing Countries* **3(01), 041-049.**

Arunee, P., Angkititrakul, S., Suksawat, F., Sparagano, O. and Kwankate K. (2012). Epidemiology and Antimicrobial resistance of *Salmonella* spp. isolated from dogs and cats in Northeastern Thailand. *Journal of Animal and Veterinary Advance* **11(5), 618-621.**

Bagcigil, A. Ikiz, F., Dokuzeylu, S., Basaran, B., Or, E. and Ozgur, N.Y. (2007). Fecal shedding of *Salmonella* spp. in dogs. *Journal Veterinary Medical Science* **69, 775-777.**

Boerlin, P, and Reid-Smith R. J. (2008). Antimicrobial resistance: Its emergence and transmission. *Animal Health Research Reviews* **9(2), 115-126.**

Cardoso, M. O., Ribeiro, A. R., dos Santos, L. R., Pilotto, F., de Moraes, H. L. S., Salle, C. T. P., Rocha, S. L. S. and Nascimento, V. P. (2006). Antibiotic resistance in *Salmonella* Enteritidis isolated

 ISSN (print): 1823-8262, ISSN (online): 2231-7538

from broiler carcasses. *Brazillian Journal of Microbiology* **37, 368-371.**

Chang, Y. C., Hsiao-Li, C., Chien-Chao, C., Kuang-Sheng, Y., Chao-Chin, C., Shih-Ling, H., Tan-Chen, L., Chih-Wei, L., Tung-Ching, C., Yu-Chih, W. and Ter-Hsin, C. (2011). *Salmonella* genomic island 1 and class 1 integron in *Salmonella* isolates from stray dogs. *African Journal of Microbiology Research* **5(23), 3907-3912.**

Cherry, B., Burns, A., Johnson, G. S., Pfeiffer, H., Dumas, N., Barrett, D. and Eidson, M. (2004). Salmonella Typhimurium outbreak associated with veterinary clinic. *Emerging Infectious Diseases* **10(12), 2249-2251.**

CLSI. (2009). Performance standards for antimicrobial susceptibility testing. Sixth informational supplement. *CLSI* document M100-516. CLSI 940 West Valley Road, Suite 140, Wayne, Pennsylvania 19087-1898, USA, ISBN 1-56238-5887.

Crump, J. A. and Mintz, E. D. (2010). Global trends in typhoid and paratyphoid fever. Clinical *Infectious Diseases* **50 (2), 241-246.**

Filip, V. I., Frank, P., Jeroen, D. B., Ivan, R., Hradecka, H., Jean-Marc, C., Christa, W., Marc, H., Richard, D. and Freddy, H. (2004). Cats as a risk for transmission of antimicrobial drug-resistant *Salmonella. Emergence Infectious Disease* **10(12), 2169-2174.**

Finley, R., Ribble, C., Aramini, J., Vandermeer, M., Popa, M., Litman, M. and Reid-Smith, R. (2007). The risk of *salmonellae* shedding by dogs fed *Salmonella*-contaminated commercial raw food diets. *Canadian Veterinary Journal* **48(1), 69-75**.

Frye, J. G. and Fedorka-Cray, P. J. (2007). Prevalence, distribution and characterization of ceftiofur resistance in *Salmonella enterica* isolated from animals in the USA from 1999 to 2003. *International Journal of Antimicrobial Agent* **30,134-142.**

Guardabassi, L., Schwarz S., Lloyd D. H. (2004). Pet animals as reservoirs of antimicrobial-resistant bacteria. *Journal Antimicrobial Chemotherapy* **54,321-332.**

Hackett, T. and Lappin M. R. (2003). Prevalence of enteric pathogens in dogs of north-central Colorado. *Journal of American Animal Hospital Association* **39, 52-56.**

International Organization for Standardization: ISO 6579 (2002). Microbiology of food and animal feeding stuffs: Horizontal method for the detection of *Salmonella* spp. **pp. 1-27.**

Jamshidi, A., Bassami, M. R. and Afshari-Nic, S. (2008). Identification of *Salmonella* serovars Typhimurium by a multiplex PCR-Based assay from poultry carcasses in Mashhad-Iran. *International Journal of Veterinary Research*, **3(1), 43-48.**

Johnson, J. K., Perencevich, E. N., Lincalis, D. P., and Venezia, R. A. (2006). Dog bite transmission of antibiotic-resistant bacteria to a human. *Infection Control and Hospital Epidemiology* **27, 762-763.**

Krumperman, P. H. (1985). Multiple antibiotic indexing of E.coli to identify high-risk sources of fecal contamination of foods. *Applied Environmental Microbiology* **46,165-170.**

Le Bouquin, S., Allain, V., Rouxel, S., Petetin, I., Picherot, M., Michel, V. and Chemaly, N. (2010). Prevalence and risk factors for *Salmonella* spp. contamination in French broiler-chicken flocks at the end of the rearing period. *Preventive Veterinary Medecine* **97(3), 245-251.**

Lefebvre, S., Waltner-Toews D., Peregrine A. S., Reid-Smith, R., Hodge, L., Arroyo, L. G., and Weese, J. S. (2006). Prevalence of zoonotic agents in dogs visiting hospitalized people in Ontario: Implications for infection control. *Journal Hospital Infection* **62, 458-466.**

Leonard, E. K., Pearl, D. L., Finley, R. L., Janecko, N., Reid-Smith, R. J., Peregrine, A. S. and Weese, J. S. (2012). Comparison of antimicrobial resistance patterns of *Salmonella* spp. and *Escherichia coli* recovered from pet dogs from volunteer households in Ontario (2005–06). *Journal of antimicrobial Chemotherapy* **67(1),174-181.**

MOH, (2005). Laboratory Surveilance. Bulletin, Disease Control Division, Ministry of Health Malaysia (October, 2005).

OIE (2008). Manual of Diagnostic Tests and Vaccines for Terrestrial Animals: Mammals, Birds and Bees. *Office international des épizooties*. Sixth edition, Paris: Office of International Des Epizooties.

Rahn, K., De Grandis, S. A., Clarke, R. C., McEwen, S. A., Galan, J. E., Ginocchio, C., Curtiss, R. and Gyles, C. L. (1992). Amplification of an *invA* gene sequence of *Salmonella* Typhimurium by polymerase chain reaction as a specific method of detection of Salmonella. *Molecular Cellular Probe* **6, 271-279.**

Sanchez, S., Hofacre, C. L., Lee M. D., Maurer, J. J., Doyle, M. P. Sanchez, S., Hofarce, C. L,. Lee, M. D., John, J. M. and Michael, P. D. (2002). Animal sources of salmonellosis in humans. *Journal of American Veterinary Medicine Association* **221(4), 492-497.**

Sato, Y., Mori, T., Koyama, T. and Nagase, H. (2000). *Salmonella* Virchow infection in an infant transmitted by household dogs. *Journal Veterinary Medical Science* **62(7), 767-769.**

Seepersadsingh, N., Adesiyun, A. A. and Seebaransingh, R. (2004). Prevalence and antimicrobial resistance of *Salmonella* spp. in non diarrhoeic dogs in Trinidad. *Journal of Veterinary Medicine, Series B* **51(7), 337-342.**

Shanmugasamy, M., Velayutham T. and Rajeswar, J. (2011). *InvA* gene specific PCR for detection of Salmonella from broilers. *Veterinary World* **4(12), 562-564.**

Tafida, S. Y., Kabir, J., Kwaga, J. K. P., Bello, M., Umuh, V. J., Yakubu, S. E. and Nok, A. J. (2013). Occurrence of *Salmonella* in retail beef and related meat products in Zaria, Nigeria. *Food Control* **32(1), 119-124.**

Tambekar, D. H., Dhanorkar, D. V., Gulhane, S. R., Khandelval, V. K. and Dudhane, M. N. (2006).

 ISSN (print): 1823-8262, ISSN (online): 2231-7538

Antibacterial susceptibility of some urinary tract pathogens to commonly used antibiotics. *African Journal of Biotechnology* **5, 1562-1565.**

Thong, K. L. and Modarressi, S. (2011). Antimicrobial resistant genes associated with *Salmonella* from retail meats and street foods. *Food Research Intern*ational **44(9), 2641-2646.**

Torpdahl, M., Hammerum, A. M. , Zachariasen, C. and Nielson, E. M. (2009). Detection of qnr genes in *Salmonella* isolated from humans in Denmark. *Journal of Antimicrobial Chemotherapy* **63(2), 406-408.**

Tsai, H.-J., Huang, H. C., Lin, C. M., Lien, Y. Y. and Chou, C. H. (2007). *Salmonellae* and campylobacters in household and stray dogs in Northern Taiwan. *Veterinary Research Communication* **31(8), 931-939.**

Umber, J. K. and Bender, J. B. (2009). Pets and antimicrobial resistance. *Veterinary Clinic North American Small Animal Practice* **39, 279-292.**

Van, T. T. H., Moutafis, G., Istivan, T., Tran, L. T. and Coloe, P. J. (2007). Detection of *Salmonella* spp. in retail raw food samples from Vietnam and characterization of their antibiotic resistance. *Applied of Environmental Microbiology* **73(21), 6885-6890.**

Wright, J. G., Tengelsen, L. A., Smith, K. E., Bender, J. B., Frank, R. K., Grendon, J. H. and Angulo, F. J. (2005). Multidrug-resistant *Salmonella* Typhimurium in four animal facilities. *Emerging infectious diseases* **11(8), 1235-1241.**

 ISSN (print): 1823-8262, ISSN (online): 2231-7538