

2 **Multi-Drug Resistance *Salmonella* Contaminates the**  
3 **Traditional Street Foods in Chittagong, Bangladesh**

4  
5 **ABSTRACT**  
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**Aims:** The oodles raising of zoonotic multi-drug resistance (MDR) *Salmonella* spp. during the last decade, especially in developing countries by repeated challenges resulting from increased and indiscriminate use of antimicrobials in food animals, fish and crop production, and human treatments is one of the dismal issues and might have a dire consequence in near future. The nascent MDR salmonella may also find their way to commonly available street foods in Bangladesh. Therefore, it is imperative to find out the existence of MDR salmonella in street foods of Bangladesh.

**Study design:** We conducted a cross-sectional study to interrogate the prevalence of *Salmonella* spp. in street food items and determine antimicrobial resistance pattern of isolated *Salmonella* spp.

**Place and Duration of Study:** The study was conducted from January to June 2016 in 5 street side markets (Agrabad, Colnel Hat, Alonkar Bazar, Bohderhat Bazar and Riazuddin Bazar) of Chittagong City Corporation (CCC) area of Bangladesh.

**Methodology:** Standard microbiological methods were used for isolation and identification of *Salmonella* spp. The antibiotic susceptibility tests were conducted by using disc diffusion method with commercially available 11 anti-microbials which are frequently used for medical and veterinary practices in Bangladesh.

**Results:** Prevalence of *Salmonella* spp. were varied from 60% to 78% among the street food items. The study revealed MDR *Salmonella* (resistance to up to 6 of 11 tested antimicrobials) from each of the food items tested. Concerning the degree of resistance, among the isolated *salmonella*, the highest resistances (100%) were detected for Ampicillin and Amoxicillin and lowest for Pefloxacin (around 13%). Moreover, the degree of resistance of *salmonella* to antimicrobials also varied among the various street food items.

**Conclusion:** The existence of MDR *salmonella* notably a high rate in the street foods cues poor hygiene in street food production and it is a major threat for the advent of foodborne zoonoses.

**Keywords:** Antimicrobial, prevalence, resistance, street foods, *Salmonella* spp.

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11 **1. INTRODUCTION**  
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13 Street foods are defined as a variety of ready-to-eat foods and beverages prepared and sold by vendors  
14 in streets and other public places for immediate consumption [1]. Microorganisms contamination of street  
15 foods has become a major public health concern globally [2,3]. Foodborne diseases are among the most  
16 widespread global public health problems of recent times, and their implication for health and economy is  
17 being increasingly recognized [4,5]. Among these pathogens, *Salmonella* are considered the most  
18 prevalent foodborne pathogens worldwide and has long been recognized as an important zoonotic  
19 pathogen of economic significance in animals and humans, predominantly in the developing countries [6].  
20 The important route of transmission of *Salmonella* organism from animals to man is via food products of  
21 animal origin which may be contaminated at the source or during handling [7]. Infections through  
22 *Salmonella* throughout the world by food have increased [8]. Street foods in particular continue to be  
23 identified as leading food sources for human Salmonellosis [9]. *Salmonella* spp. infection of street foods  
24 has important implication on public health worldwide [10]. The majority of human infection of *Salmonella*  
25 is related to the ingestion of contaminated foods such as poultry, beef, pork, egg, milk, cheese, seafood,  
26 fruit, juices and vegetables [11,12,13]. Worldwide *Salmonella* is a significant food and water-borne  
27 zoonotic pathogens [14]. In developing countries like Bangladesh antimicrobial resistance occur due to an  
28 increased and indiscriminate use of antibiotics in food animals, environments and human [6,15].  
29 Throughout the previous era, multi-drug resistance of *Salmonella* spp. has increased in excessive amount  
30 [16]. It is presumed that the extensive use of antibiotics, especially in livestock production, may have

31 resulted in the increasing incidence of antibiotic resistance in food borne *Salmonella* spp. and other  
32 microorganisms [17]. Street foods in particular continue to be identified as leading food sources for  
33 human Salmonellosis [18]. It is not yet clear as to which route is most important for *Salmonella* to  
34 contaminate the foods, which may be contaminated with *Salmonella* by vertical transmission and/or  
35 horizontal transmission [19]. Very few studies were conducted on isolation and drug resistance in  
36 *Salmonella* spp. throughout the world from street foods. In Bangladesh, evaluation of microbiological  
37 prevalence and antimicrobial susceptibility in common street foods is also negligible. This study,  
38 therefore, aimed to investigate prevalence of *Salmonella* spp. in common street foods (Fuska, Sugarcane  
39 juice and Borhani) and antimicrobial resistance pattern of *Salmonella* isolates from these foods to  
40 commonly used antimicrobials in Bangladesh.

## 41 **2. MATERIALS AND METHODS**

42 **2.1 Study Design and sampling area:** A cross-sectional study was conducted from January to June  
43 2016 in 5 street side markets (Agrabad, Colnel Hat, Alonkar Bazar, Bohderhat Bazar and Riazuddin  
44 Bazar) of Chittagong City Corporation (CCC) area of Bangladesh. These places are the hot spots of  
45 street food trading.

46 **2.2 Sample collection and preservation:** Among the various street foods, we considered only 3  
47 Bangladeshi traditional street food items: (i) *Fuska*, a fried food prepared mostly from flower, eggs and  
48 various spices; (ii) *Sugarcane juice*, a drink prepared from the trunk of mature sugarcane by pressure  
49 extraction and (iii) *Borhani*, a drink prepared from milk card with incorporation of rock salt and spices. A  
50 total of 143 samples of various street foods (Fuska surface water: 55, Sugarcane juice: 58 and Borhani:  
51 30) were collected from 5 aforementioned street markets. All the samples were collected in sterile vials  
52 containing 6 ml amines transport media (Oxoid) and transported to the Poultry Research and Training  
53 Center (PRTC) laboratory, Chittagong Veterinary and Animal Sciences University (CVASU) using an  
54 insulated ice cool box.

55 **2.3 Salmonella isolation and identification procedures:** A previously described protocol [20] was used  
56 for this study for the isolation and identification of *Salmonella*. . Briefly, 1ml of food sample was  
57 transferred into 10 ml Mannitol Selenite Broth (Oxoid) and incubated at 37°C for 18 hours. After  
58 incubation, a loop full of broth was streaked on Xylose Lysine Deoxycholate medium and incubated at  
59 37°C for 24 hours. Colonies with black centers were considered presumptive *Salmonella* spp.  
60 Presumptive colonies were grown on blood agar and the *Salmonella* was confirmed based on cultural  
61 properties and biochemical tests (Urease: Negative, Oxidase: Negative and Catalase: Positive).

62 **2.4 Selection of antimicrobials for antimicrobial susceptibility testing:** In the present investigation,  
63 the *Salmonella* isolates were tested whether they are resistant or not to antimicrobials by using commonly  
64 used antimicrobial (Ampicillin, Amoxicillin, Ciprofloxacin, Enrofloxacin, Pefloxacin, Colistin Sulphate,  
65 Oxytetracycline, Tetracycline, Azithromycin, Erythromycin, Ceftriaxone) in Bangladesh.

66 **2.5 Anti-microbial Susceptibility Test:** An antimicrobial susceptibility test was done by disk diffusion  
67 method as described by Clinical and Laboratory Standards Institute (CLSI) [21]. In this method, Mueller  
68 Hinton agar plates were as per instructions provided by the manufacturer. McFarland 0.5 turbidity  
69 standards were prepared as the standard guidelines described by the CLSI. After swabbing the pure  
70 salmonella suspension with cotton swab, selected antibiotic disks were placed on the surface of the plate  
71 at equidistance. The plates were then kept at 4°C for 1-2 hours for proper diffusion of antibiotics. The  
72 plates were then incubated for 24 hours at 37°C. The zone of inhibition was observed for antibiotic  
73 sensitivity or resistance, and zone diameter was measured. The sizes of zones of inhibition were  
74 interpreted by referring to zone diameter interpretive standards from NCCLS 2000 [21] and the isolates  
75 were considered as sensitive, intermediately sensitive, or resistant to these tested antimicrobials  
76 according to the standard [21].

## 77 **2.6 Data Analysis**

78 Field and laboratory data were stored and then cleaned in the MS Excel-2007 program before exporting  
79 to STATA/IC-13 for analysis. Descriptive analysis was performed to know the frequency and distribution  
80 of *Salmonella* and antibiotic resistance pattern. Chi-square test was performed to compare the  
81 frequencies between groups.

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84 **3. RESULTS AND DISCUSSION**

85  
86 **3.1 Realm of *Salmonella* in street foods:**

87 We first looked for the existence of salmonella based on cultural properties and biochemical test among  
88 the collected food samples and expressed them in frequencies and percentages (Table1).

89  
90 **Table 1. Prevalence of *Salmonella* in different samples and sampling sites**

Variables	Categories	Number of samples	Positive (%)	χ <sup>2</sup> -value	P-value
Samples	Fuska surface water	55	40 (72.72)	3.057	0.216
	Sugar cane juice	58	45 (77.58)		
	Borhani	30	18 (60.00)		
Sampling sites	Agrabad	30	20 (66.67)	1.502	0.826
	Colonel Hat	35	24 (68.57)		
	Alonkar Bazar	25	20 (80.00)		
	Bohderhat Bazar	31	23 (74.19)		
	Riazuddin Bazar	22	16 (72.72)		

91 We found that, considering the categories of food item, the highest prevalence was found in sugar cane  
92 juice (77.58%) and lowest (60.00%) in borhani. Giving consideration to sites of sample collection, the  
93 prevalence was highest (80%) in Alonker Bazar and lowest (66.67%) in Agrabad. Neither types of food  
94 item nor the sites of sample collection were varied significantly (p>0.2) in terms of prevalence of  
95 *salmonella*.

96  
97 **3.2 Drug-resistance *salmonella*:**

98 We, investigated the *salmonella* positive samples, for the existence of drug resistance *salmonella* by  
99 antimicrobial susceptibility test and the outcomes are presented as each category of food items (Table 2).

100  
101 **Table 2. Antimicrobial resistance pattern of *Salmonella* isolates from fuska surface water,  
102 Sugarcane juice and Borhani**

Antibiotics	Fuska surface water				Sugarcane juice				Borhani			
	N	R (%)	I (%)	S (%)	N	R (%)	I (%)	S (%)	N	R (%)	I (%)	S (%)
Ampicillin	40	100	0	0	45	100	0	0	18	100	0	0
Amoxicillin	40	100	0	0	45	100	0	0	18	100	0	0
Ciprofloxacin	40	27.5	42.5	30	45	60	28.89	11.11	18	11.11	5.55	83.33
Enrofloxacin	40	60	37.5	2.5	45	51.11	48.89	0	18	38.88	5.55	55.55
Pefloxacin	40	12.5	35	52.5	45	40	42.22	17.78	18	38.88	5.55	55.55
Colistin	40	57.5	7.5	35	45	91.11	0	8.89	18	33.33	50	16.66
Sulphate												
Oxytetracycline	40	62.5	17.5	20	45	86.67	13.33	0	18	100	0	0
Tetracycline	40	82.5	12.5	5	45	82.22	17.78	0	18	100	0	0
Azithromycin	40	95	5	0	45	84.44	15.55	0	18	100	0	0
Erythromycin	40	90	10	0	45	100	0	0	18	100	0	0
Ceftriaxone	40	70	30	0	45	62.22	26.67	11.11	18	0	0	100

104  
105 N: Number of *salmonella* positive isolates in each categories of food; R: Resistance; I: Intermediate and  
106 S: Sensitive.

107 The *Salmonella* isolates were found to be at least a certain degree of resistant to all of the anti-microbials  
108 tested. In general, the resistance was highest (100%) for Ampicillin and Amoxicillin followed by  
109 Azithromycin (95%), Erythromycin (90%) and lowest in Pefloxacin (around 13%), and none of ani-  
110 microbials were 100% sensitive to *Salmonella*.

111 Considering the data on sugarcane juice, the highest percentages of drug-resistance *Salmonella* (100%)

112 were detected to Ampicillin, Amoxicillin and Erythromycin followed by Colistin Sulphate (around 92%),  
113 Oxytetracycline (approximately 87%), and lowest in Pefloxacin (40%).

114 In a view to Borhani, the highest rate of antimicrobial resistant *salmonella* were found (100%) against  
115 Ampicillin, Amoxicillin, Oxytetracycline, Tetracycline, Azithromycin, and Erythromycin followed by  
116 Enrofloxacin and Pefloxacin (55.55%). The highest sensitive drugs against *Salmonella* isolates was  
117 Ceftriaxone (100%) followed by Ciprofloxacin (84%), Enrofloxacin and Pefloxacin (56%).

118  
119 Foods are important part of the human health [22]. Consuming un-hygienic street foods has been  
120 associated with negative health impacts. Street foods that are improperly handled can be a source of  
121 food-borne diseases such as Salmonellosis [5]. The aim of this study was to determine the prevalence of  
122 *Salmonella* spp. in street foods along with the prevalence and pattern of antimicrobial resistance of  
123 isolated *Salmonella* spp. against commonly using antimicrobials in selected areas of Chittagong City  
124 Corporation, Bangladesh. The results of the present study indicated that, a considerable prevalence of  
125 *Salmonella* in selected street foods and similar finding was reported in Vietnam [23]. The prevalence  
126 levels of *Salmonella* infection in street foods reported in United Kingdom, was from zero to 7% [24,25] but  
127 scenario of prevalence in developing countries were much higher, might be due to not maintaining the  
128 hygienic measurement in food production and processing. Salmonellosis can be controlled in animal  
129 origin food production by several ways such as improved bio-security, vaccination, introduction of novel  
130 immune-potentiators etc. with limited use of antimicrobials [26]. An organism develops resistance against  
131 an antibiotic by repeated low dose exposure. Food born organism might get exposure to low dose  
132 repeated antibiotic exposure from environmental contamination as most of the antibiotics and  
133 antimicrobials used in human and food-producing animal find their way to environment as final  
134 destination. The situation in developing countries like Bangladesh may be exaggerated by easy  
135 accessibility of antimicrobials at a cheaper price and their extensive use in food production system [27].  
136 Thus, there is widespread availability and uncontrolled use of antibiotics poses the antimicrobial  
137 resistance in food products, which is the actual threat of public health [16]. 100% resistant Ampicillin and  
138 Amoxicillin were found in the present study almost similar (87-100%) resistance that was reported earlier  
139 in Bangladesh [14,28,29]. Ampicillin and Amoxicillin antibiotics resistant might have been due to use as  
140 growth promoters. Cross antimicrobial resistance cannot be ignored as it is evident in many earlier  
141 studies and causes higher resistance to Ampicillin and Amoxicillin [15,30,31].

142  
143 The high resistance of Ampicillin and Amoxicillin is a great threat of public health. Resistance to  
144 Ciprofloxacin was recorded relatively higher proportions in present study. Ciprofloxacin is used for the  
145 treatment of Salmonellosis in humans [32,33]. Among Fluoroquinolones, resistance to Ciprofloxacin was  
146 found comparatively higher in the present study as compared to 35% resistance in USA [34] and 10.2-  
147 16.8% in Germany [35]. In present study higher resistant of Enrofloxacin were evident against the  
148 *Salmonella* isolates. In several investigations resistant of Enrofloxacin were found 14% [36] and 0.6-2%  
149 [37] in Australia that were comparatively lower than the current investigation. In the current study  
150 resistance to Pefloxacin was relatively in lower proportions. Similar type of result was found in  
151 Bangladesh in case of layer poultry *salmonella* isolates [12]. It is less used for the treatment of  
152 Salmonellosis in humans and animals [38] that might be a cause of less resistance. The resistance  
153 pattern of *Salmonella* to Colistin Sulphate was not high for the current study. Resistances to Colistin  
154 sulphate among street foods isolates are reported from Senegal [39] Mexico [40] and USA [26] were  
155 more or less similar to the current study result. Oxytetracycline and Tetracycline is most commonly used  
156 antibiotics in Bangladesh that is might be the cause of higher resistant revealed in present study and the  
157 results agreed with the earlier researchers of Bangladesh and India [28,41]. *Salmonella* was resistance  
158 to Azithromycin in the present study, similar result was found in several reports of Bangladesh. It could be  
159 happened due to heavily use of Azithromycin against different infectious diseases including  
160 Salmonellosis. It was observed that higher resistant of Enrofloxacin against the *Salmonella* isolates in the  
161 present study. This result is consistent with many other previous studies in street foods in developing  
162 countries including Bangladesh. In the present study highest sensitive drugs against *Salmonella* isolates  
163 were found in Ceftriaxone similar result was found recently in Bangladesh [42,43]. It may be due to less  
164 exposure of this drug to the community.

165  
166 All the isolates were resistant to Ampicillin, Amoxicillin, Oxytetracycline, Tetracycline, Erythromycin, and  
167 Azithromycin. This study has also confirmed the prevalence of varying drug resistance pattern among the

168 *Salmonella* isolates. This may be due to the presence of more than one serovar of *Salmonella* in the  
169 various food items. A higher proportion of antibiotic resistance in *Salmonella enteritidis* has been reported  
170 from southern Brazil [44]. Increasing antibiotic resistance can limit the therapeutic options available to  
171 physicians for clinical cases that require antibiotic treatment. There is a need to find strategies to minimize  
172 the risk of spreading antimicrobial resistance among animal and human populations.

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#### 175 **4. CONCLUSION**

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177 *Salmonella* is a well-known food born threat in a tropical country like Bangladesh. The current study  
178 revealed a relatively greater prevalence of *salmonella* among the street foods. Moreover, the *Salmonella*  
179 isolates from most of the food samples were multidrug resistant. The findings of the current study suggest  
180 that food born drug-resistant *Salmonella* is one of the major concerning issues in Bangladesh. The poor  
181 sanitation and handling of sewage could be a source of contamination. The excess utilization of  
182 antibiotics in the veterinary, human and fish practice might be the cause of increased resistance to  
183 different antibiotics. The valuable information of these research findings might be useful for awareness  
184 buildup among the common people, consumers and street food trader. Strict hygienic measures like-  
185 efficient hand cleaning, cleaning of food contact surfaces and utensils might reduce *salmonella*  
186 contamination to those street foods. In the view of drug-resistant *Salmonella*, obviously, it is not possible  
187 to stop the use of antibiotics, but a rational use may minimize the risk.

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#### 190 **COMPETING INTERESTS**

191 Authors have declared that no competing interests exist.

192

#### 193 **ETHICAL APPROVAL**

194

195 Written consent from the salesmen of mentioned products were taken before sample collection. No  
196 animal or human experiments were involved here.

197

#### 198 **REFERENCES**

199

- 200 1. Rane S. Street vended food in developing world: hazard analyses. Indian J microbiol. 2011;  
201 51:100-6.
- 202 2. Muleta D, Ashenafi M. *Salmonella*, *Shigella* and growth potential of other food-borne pathogens in  
203 Ethiopian street vended foods. East Afr Med J. 2001; 78:576-80.
- 204 3. Omemu A, Aderoju S. Food safety knowledge and practices of street food vendors in the city of  
205 Abeokuta, Nigeria. Food Control. 2008; 19:396-402.
- 206 4. De Buyser M-L, Dufour B, Maire M, Lafarge V. Implication of milk and milk products in food-borne  
207 diseases in France and in different industrialised countries. Int J Food Microbiol. 2001; 67:1-17.
- 208 5. Newell DG, Koopmans M, Verhoef L, Duizer E, Aidara-Kane A, Sprong H, et al. Food-borne  
209 diseases the challenges of 20 years ago still persist while new ones continue to emerge. Int J  
210 Food Microbiol. 2010; 139:13-15.
- 211 6. Faruq AA, Hassan MM, Uddin MM, Rahman ML, Rakib TM, Alam M, et al. Prevalence and  
212 multidrug resistance pattern of *Salmonella* isolated from resident wild birds of Bangladesh. Int J  
213 One Health. 2016; 2:35-41.
- 214 7. Forshell LP, Wierup M. *Salmonella* contamination: a significant challenge to the global marketing  
215 of animal food products. Rev sci tech Off int Epiz. 2006; 25:541-54.
- 216 8. Lues JF, Rasephei MR, Venter P, Theron MM. Assessing food safety and associated food  
217 handling practices in street food vending. Int J Environ Health Res. 2006; 16:319-28.
- 218 9. Choudhury M, Mahanta L, Goswami J, Mazumder M, Pegoo B. Socio-economic profile and food  
219 safety knowledge and practice of street food vendors in the city of Guwahati, Assam, India. Food  
220 Control. 2011; 22:196-203.

- 221 10. Tunung R, Chai L, Usha M, Lee H, Fatimah A, Farinazleen M, et al. Characterization of  
222 *Salmonella* enterica isolated from street food and clinical samples in Malaysia. ASEAN Food J.  
223 2007; 14:161.
- 224 11. Sattar S, Hassan MM, Faruq AA, Alam M, Al Faruk MS, Chowdhury S, et al. Antibiotic residues in  
225 broiler and layer meat in Chittagong district of Bangladesh. Vet World. 2014; 7:467-471.
- 226 12. Hassan MM, Amin KB, Ahaduzzaman M, Alam M, Faruk M, Uddin I. Antimicrobial resistance  
227 pattern against *E. coli* and *Salmonella* in layer poultry. Res J Vet Pract. 2014; 2:30-35.
- 228 13. Hassan M, Ahaduzzaman M, Alam M, Bari MS, Amin K, Faruq AA. Antimicrobial resistance  
229 pattern against *E. coli* and *Salmonella* spp. in environmental effluents. Int J of Natu Sci. 2016;  
230 5:52-8.
- 231 14. Chowdhury S, Hassan MM, Alam M, Sattar S, Bari MS, Saifuddin A, et al. Antibiotic residues in  
232 milk and eggs of commercial and local farms at Chittagong, Bangladesh. Vet World. 2015; 8:467.
- 233 15. Islam A, Saifuddin A, Faruq AA, Islam S, Shano S, Alam M, et al. Antimicrobial residues in tissues  
234 and eggs of laying hens at Chittagong, Bangladesh. Int J One Health. 2016;2:75-80.
- 235 16. Mahmud T, Hassan MM, Alam M, Khan MM, Bari MS, Islam A. Prevalence and multidrug-resistant  
236 pattern of *Salmonella* from the eggs and egg-storing trays of retail markets of Bangladesh. Int J  
237 One Health. 2016;2: 7-11.
- 238 17. Islam A, Nath AD, Islam S, Chakma S, Faruq AA, Hassan MM, et al. Isolation, identification and  
239 antimicrobial resistance profile of *Staphylococcus aureus* in Cockroaches (*Periplaneta*  
240 *americana*). J Adv Vet Animal Res. 2016;3: 221-228.
- 241 18. Mead G, Lammerding AM, Cox N, Doyle MP, Humbert F, Kulikovskiy A, et al. Scientific and  
242 technical factors affecting the setting of Salmonella criteria for raw poultry: a global perspective. J  
243 Food Prot. 2010; 73:1566-90.
- 244 19. Gantois I, Ducatelle R, Pasmans F, Haesebrouck F, Gast R, Humphrey TJ, et al. Mechanisms of  
245 egg contamination by *Salmonella* Enteritidis. FEMS Microbiol Rev. 2009; 33:718-38.
- 246 20. Hoque M, Burgess G, Greenhil A, Hedlefs R, Skerratt L. Causes of morbidity and mortality of wild  
247 aquatic birds at Billabong Sanctuary, Townsville, North Queensland, Australia. Avian Dis. 2012;  
248 56:249-56.
- 249 21. Wikler MA. Performance standards for antimicrobial susceptibility testing: Seventeenth  
250 informational supplement: Clinical and Laboratory Standards Institute. 2013;33(1):15-180.
- 251 22. Magnusson MK, Arvola A, Hursti U-KK, Åberg L, Sjödn P-O. Choice of organic foods is related to  
252 perceived consequences for human health and to environmentally friendly behaviour. Appetite.  
253 2003; 40:109-17.
- 254 23. Van TTH, Moutafis G, Istivan T, Tran LT, Coloe PJ. Detection of *Salmonella* spp. in retail raw food  
255 samples from Vietnam and characterization of their antibiotic resistance. Appl Environ Microbiol.  
256 2007; 73:6885-90.
- 257 24. Humphrey T. Contamination of egg shell and contents with *Salmonella* enteritidis: a review. Int J  
258 Food Microbiol. 1994; 21: 31-40.
- 259 25. Evans MR, Lane W, Ribeiro CD. *Salmonella* enteritidis PT6: another egg-associated salmonellosis.  
260 Emerg inf dis. 1998; 4: 667.
- 261 26. Zhao S, White D, Friedman S, Glenn A, Blickenstaff K, Ayers S, et al. Antimicrobial resistance in  
262 *Salmonella* enterica serovar Heidelberg isolates from retail meats, including poultry, from 2002 to  
263 2006. Appl Environ Microbiol. 2008; 74:6656-62.
- 264 27. Prakash B, Krishnappa G, Muniyappa L, Kumar BS. Epidemiological characterization of avian  
265 *Salmonella* enterica serovar infections in India. Int J Poult Sci. 2005; 4:388-95.
- 266 28. Suresh T, Hatha A, Sreenivasan D, Sangeetha N, Lashmanaperumalsamy P. Prevalence and  
267 antimicrobial resistance of *Salmonella* enteritidis and other *salmonella* in the eggs and egg-storing  
268 trays from retails markets of Coimbatore, South India. Food Microbiol. 2006; 23:294-9.
- 269 29. Begum K, Reza TA, Haque M, Hossain A, Hassan FK, Hasan SN, et al. Isolation, identification  
270 and antibiotic resistance pattern of *Salmonella* spp. from chicken eggs, intestines and  
271 environmental samples. Bangladesh Pharm J. 2010; 13:23-7.
- 272 30. Rowe B, Ward L, Threlfall E, Wallace M, Yousif A. Spread of multiresistant *Salmonella* typhl. The  
273 Lancet. 1990; 336: 1065-66.
- 274 31. Gupta V, Ray P, Sharma M. Antimicrobial resistance pattern of *Shigella* & non-typhi *Salmonella*  
275 isolated from patients with diarrhoea. Indian J Med Res. 1999; 109: 43.

- 276 32. Brown N, Millar M, Frost J, Rowe B. Ciprofloxacin resistance in *Salmonella* paratyphi A. J  
277 Antimicrob Chemother. 1994; 33: 1258-1259.
- 278 33. Griggs D, Hall M, Jin Y, Piddock L. Quinolone resistance in veterinary isolates of *Salmonella*. J  
279 Antimicrob Chemother. 1994; 33: 1173-1189.
- 280 34. Cai H, Lu L, Muckle C, Prescott J, Chen S. Development of a novel protein microarray method for  
281 serotyping *Salmonella* enterica strains. J Clin Microbiol. 2005; 43:3427-30.
- 282 35. Heisig P, Kratz B, Halle E, Gräser Y, Altwegg M, Rabsch W, et al. Identification of DNA gyrase A  
283 mutations in ciprofloxacin-resistant isolates of *Salmonella* typhimurium from men and cattle in  
284 Germany. Microb Drug Resist. 1995; 1:211-8.
- 285 36. EFSA E. The European Union summary report on antimicrobial resistance in zoonotic and  
286 indicator bacteria from humans, animals and food in 2010. EFSA J. 2016; 10:2598.
- 287 37. Cheng AC, Turnidge J, Collignon P, Looke D, Barton M, Gottlieb T. Control of fluoroquinolone  
288 resistance through successful regulation, Australia. Emerg Infect Dis. 2012; 18:1453.
- 289 38. Weill F-X, Lailier R, Praud K, Kérouanton A, Fabre L, Brisabois A, et al. Emergence of extended-  
290 spectrum- $\beta$ -lactamase (CTX-M-9)-producing multiresistant strains of *Salmonella* enterica serotype  
291 Virchow in poultry and humans in France. J Clin Microbiol. 2004; 42:5767-73.
- 292 39. Bada-Alamedji R, Fofana A, Seydi M, Akakpo AJ. Antimicrobial resistance of *Salmonella* isolated  
293 from poultry carcasses in Dakar (Senegal). Braz J Microbiol. 2006; 37:510-5.
- 294 40. Zaidi MB, McDermott PF, Fedorka-Cray P, Leon V, Canche C, Hubert SK, et al. Nontyphoidal  
295 *Salmonella* from human clinical cases, asymptomatic children, and raw retail meats in Yucatan,  
296 Mexico. Clin Infect Dis. 2006; 42:21-8.
- 297 41. Akter M, Choudhury K, Rahman M, Islam M. Seroprevalence of salmonellosis in layer chickens  
298 with isolation, identification and antibiogram study of their causal agents. Bangladesh J Vet Med.  
299 2007; 5:39-42.
- 300 42. Asna S, Haq JA, Rahman MM. Nalidixic acid-resistant *Salmonella* enterica serovar Typhi with  
301 decreased susceptibility to ciprofloxacin caused treatment failure: a report from Bangladesh. Jpn J  
302 Infect Dis. 2003; 56:32-3.
- 303 43. Mahbubur R, Shoma S, Rashid H, El Arifeen S, Baqui A, Siddique A, et al. Increasing spectrum in  
304 antimicrobial resistance of *Shigella* isolates in Bangladesh: resistance to azithromycin and  
305 ceftriaxone and decreased susceptibility to ciprofloxacin. J Health Popul Nutr. 2007; 25:158.
- 306 44. de Oliveira SID, Flores FS, dos Santos LR, Brandelli A. Antimicrobial resistance in *Salmonella*  
307 enteritidis strains isolated from broiler carcasses, food, human and poultry-related samples. Int J  
308 Food Microbiol. 2005; 97:297-305.