Journal of Food Protection, Vol. 75, No. 6, 2012, Pages 1134–1138
doi:10.4315/0362-028X.JFP-11-513

Research Note

Prevalence of *Salmonella* on Retail Broiler Chicken Meat Carcasses in Colombia

PILAR DONADO-GODOY,[1] VIVIANA CLAVIJO,[1] MARIBEL LEÓN,[2] MC ALLISTER TAFUR,[2] SEBASTIAN GONZALES,[1] MICHAEL HUME,[3] WALID ALALI,[4]* ISABEL WALLS,[5] DANILO M. A. LO FO WONG,[6] AND M. P. DOYLE[4]

[1]*CORPOICA—Corporación Colombiana de Investigación Agropecuaria, CBB—Centro de Biotecnología y Bioindustria, Km 14, Via Mosquera, Cundinamarca, Colombia;* [2]*Instituto Colombiano Agropecuario, Carrera 41 No. 17-81, Bogotá DC, Colombia;* [3]*U.S. Department of Agriculture, Agricultural Research Service, Food Animal Protection Research Laboratory, 2881 F&B Road, College Station, Texas 77845, USA;* [4]*Center for Food Safety, University of Georgia, Griffin, Georgia 30223, USA;* [5]*U.S. Department of Agriculture, National Institute of Food and Agriculture, Washington, D.C. 20250, USA; and* [6]*Food Safety and Zoonoses, World Health Organization, Geneva 27, Switzerland*

MS 11-513: Received 20 November 2011/Accepted 20 January 2012

ABSTRACT

A cross-sectional study was performed to estimate the prevalence of *Salmonella* on retail market chicken carcasses in Colombia. A total of 1,003 broiler chicken carcasses from 23 departments (one city per department) were collected via a stratified sampling method. Carcass rinses were tested for the presence of *Salmonella* by conventional culture methods. *Salmonella* strains were isolated from 27% of the carcasses sampled. Logistic regression analysis was used to determine potential risk factors for *Salmonella* contamination associated with the chicken production system (conventional versus free-range), storage condition (chilled versus frozen), retail store type (supermarket, independent, and wet market), poultry company (integrated company versus nonintegrated company), and socioeconomic stratum. Chickens from a nonintegrated poultry company were associated with a significantly ($P <$ 0.05) greater risk of *Salmonella* contamination (odds ratio, 2.0) than were chickens from an integrated company. Chilled chickens had a significantly ($P < 0.05$) higher risk of *Salmonella* contamination (odds ratio, 4.3) than did frozen chicken carcasses.

Salmonellosis is one of the most important foodborne diseases in many countries. Few countries have a surveillance system that estimates the burden of salmonellosis in human populations *(9, 27)*. Human salmonellosis is frequently associated with the consumption of poultry products *(3, 11, 13, 20)*. In emerging countries such as Colombia, poultry meat is the most important and least expensive source of animal protein. The production of chicken meat in Colombia reached 1.02 million tons in 2008, and the consumption of chicken per capita has steadily increased from 14 kg/year in 2001 to 23 kg/year in 2008 *(8)*. Although the productivity of the Colombian poultry industry has achieved international standards, additional advances are needed in the sanitary and food safety system to reduce contamination by infectious pathogens such as *Salmonella*. Data regarding the prevalence of *Salmonella* in animal production and in humans are limited and fragmented in Colombia. Results from a study conducted by the Planning Department in Colombia in 2005 revealed that 7% ($n = 385$) of raw chicken carcasses sampled at slaughter plants were *Salmonella* positive *(5)*. A cross-sectional study conducted in 2010 in one of the most important poultry-producing regions of Colombia revealed *Salmonella* prevalences of 40% ($n = 70$) and 26% ($n = 200$) on poultry farms and retail chicken meat, respectively *(7)*. However, the study was limited to one city (Bogotá), the sample size was relatively small, two types of markets were included (supermarket and independent), and only chicken thigh samples were assayed. The objective of the current study was to establish a baseline prevalence for *Salmonella* on raw chicken meat at the retail level over a wide geographical distribution in Colombia. We envisioned the data collected to be used by the Colombian poultry industry to improve sanitary conditions of their products and to prepare for the imminent access to international trade markets. Furthermore, the data would also be of interest to public health, food safety, and animal health personnel to design policies and strategies to reduce *Salmonella* contamination along the poultry production food chain.

MATERIALS AND METHODS

Study design and sampling procedure. A cross-sectional study was carried out between October 2010 and April 2011 to determine the prevalence of *Salmonella* on retail chicken meat in Colombia. A sample size of 1,003 broiler carcasses was determined, with an absolute error of 4% with a 99.5% level of confidence and an expected prevalence of 26%, which was based on a previous study *(13)*. Subsequently, a stratified sampling strategy was applied in which department and city, locality (i.e., district), and store type were the primary, secondary, and tertiary units, respectively. Whole chicken carcasses were collected from retail stores located in the capital cities of the 23 most populated departments (provinces) (from a total of 32 departments) of Colombia,

* Author for correspondence. Tel: 770-467-6066; Fax: 770-229-3216; E-mail: walali@uga.edu.

TABLE 1. *Population of cities sampled, their relative population percentage, number of chicken samples collected, and* Salmonella *prevalence per city*

Department	City	Population	% of total population	No. of samples[a]	No. (%) of *Salmonella*-positive samples
Sucre	Sincelejo	237,618	1.2	11	6 (54.5)
Arauca	Arauca	75,577	0.4	4	2 (50.0)
N. de Santander	Cúcuta	587,676	3.1	28	13 (46.4)
Cundinamarca	Bogotá	6,840,166	35.9	368	159 (43.2)
Santander	Bucaramanga	516,512	2.7	30	11 (36.7)
Atlántico	Barranquilla	1,146,359	6.0	54	18 (33.3)
Putumayo	Mocoa	35,755	0.2	3	1 (33.3)
Tolima	Ibagué	498,401	2.6	27	8 (29.6)
Cesar	Valledupar	354,180	1.9	17	5 (29.4)
Nariño	Pasto	382,618	2.0	20	5 (25.0)
Huila	Neiva	352,859	1.9	19	4 (21.1)
Meta	Villavicencio	380,222	2.0	20	4 (20.0)
Casanare	Yopal	106,822	0.6	6	1 (16.67)
Cordoba	Monteria	330,144	1.7	19	3 (15.8)
Magdalena	Santa Marta	415,270	2.2	20	3 (15.0)
V. del Cauca	Cali	2,119,908	11.1	113	15 (13.3)
Caldas	Manizales	379,972	2.0	20	2 (10.0)
Risaralda	Pereira	443,554	2.3	24	2 (8.3)
Bolívar	Cartagena	892,545	4.7	42	3 (7.1)
Antioquia	Medellín	2,214,494	11.6	118	5 (4.2)
Quindío	Armenia	306,930	1.6	16	0 (0.0)
Cauca	Popayán	257,512	1.4	14	0 (0.0)
Boyacá	Tunja	170,000	0.9	10	0 (0.0)
Total		19,045,094		1,003	270 (27)

[a] The number of samples was based on the relative population size of the selected cities.

which presented the highest consumption of chicken meat products (~90%). These capital cities represented both urban and rural communites. The number of samples per city and the locality within a city were based on the relative population size of the selected cities and locality of Colombia (Table 1). Within each locality, the number of selected retail stores per market type was determined proportionally to the total number of store types within each locality.

Chicken samples were collected from three types of retail stores: supermarkets, independent markets, and wet markets. Supermarkets were nationally recognized brand chain stores that sold chickens chilled or frozen, supplied mostly by large integrated poultry companies. Free-range chickens were also available in this type of retail market. Independent markets were those that belonged to either integrated poultry companies or small-scale nonintegrated poultry companies. Carcasses of conventionally raised or free-range chickens were sold either chilled or frozen. Wet markets were open markets (within a shopping plaza) that included meat stores as well as fruit and vegetable stores. Similarly, conventionally raised or free-range chickens were sold in wet markets and retailed as either chilled or frozen.

Data recorded for the chicken samples included the following variables: retail store type, chicken production system, storage type, poultry company, socioeconomic stratum (SES), retail store name, retail store address, locality, and chicken price. The SES in Colombia is defined on the basis of location and income, whereby stratum 1 is the lowest and stratum 6 is the highest. Descriptions of the variables and their categories are summarized in Table 2.

***Salmonella* analysis.** Whole broiler chicken carcasses (chilled or frozen) were purchased from retail stores and held at 4°C in insulated containers and transported to the laboratory within 24 h. Upon arrival at the laboratory, frozen chickens were thawed at room temperature (within 2 h). Isolation and identification of *Salmonella* were conducted according to the methodology recommended by the U.S. Department of Agriculture, Food Safety and Inspection Service *(23)*. Each carcass was placed in a Whirl-Pak bag, and then 400 ml of sterile buffered peptone water (Difco) was added. The bag was hand massaged for 5 min, and 30 ml of the chicken rinsate was mixed with 30 ml of sterile buffered peptone water and incubated for 20 to 24 h at 37°C. This incubation was followed by an enrichment of 0.2 ml of buffered peptone water culture in 10 ml of modified Rappaport-Vassiliadis (Difco) broth for 20 to 24 h at 42°C. Also, a portion (0.5 ml) of the chicken rinsate was transferred to 10 ml of tetrathionate broth (Difco) and incubated for 22 to 24 h at 42°C. A loopful from each of the enrichment broths (modified Rappaport-Vassiliadis and tetrathionate broth) following incubation was streaked onto brilliant green sulfa (Difco) and on xylose lysine Tergitol 4 (Difco) agar plates and incubated for 22 to 24 h at 37°C. Three typical colonies of *Salmonella* were selected per plate, inoculated onto triple sugar iron agar (Difco) and lysine iron agar (Difco), and then incubated at 37°C for 22 to 24 h. Isolates with typical *Salmonella* colony characteristics were confirmed by agglutination by *Salmonella* Poly-O (A & Vi; Difco) antiserum. Another confirmation test of *Salmonella* genus was performed in parallel by an automated BD Phoenix system according to the manufacturer's instructions (Difco, BD, Sparks, MD). Colonies confirmed as *Salmonella* were preserved at −70°C in skim milk.

Data management and statistical analysis. Data collected from all samples were tabulated with Microsoft Excel 2007 software, and all variables were codified by numbers. Sample-size parameters were determined by Win episcope 2.0 *(2)*. The relationship between potential risk factors (SES, retail store type,

TABLE 2. *Summary of variables investigated as potential risk factors for* Salmonella *contamination of raw chicken*

Variable	Categories	Description
Retail store type	Wet market	Open food market in plaza
	Supermarket	A large self-service retail market
	Independent	Butchers, company stores, or small neighborhood stores
Chicken production system	Free-range	Free-range chickens characterized by a yellow skin color
	Conventional	Normal chicken characteristic was white skin color
Storage condition	Chilled	Temp at the moment of collection was 4–10°C
	Frozen	Temp at the moment of collection was <-5°C
Poultry company	Integrated company	Company that typically handles the entire production and processing cycle of a chicken (hatching, feed, production, processing, and marketing)
	Nonintegrated company	The entire production cycle of a chicken is handled by several companies
SES	1–6	The socioeconomic status based on the location of the owner's residence and income, with 1 being the lowest and 6 the highest

chicken production system, retail storage condition, and poultry company) and the prevalence of *Salmonella* was assessed using logistic regression models in STATA software, version 10.1 (Stata Corp., College Station, TX). Odds ratios and *P* values were obtained for the risk factor analysis.

RESULTS

Samples and retail stores. A total of 1,003 broiler chicken carcasses from 23 cities in Colombia were analyzed for *Salmonella* contamination (Table 1). Chicken samples were collected from independent retail stores (42%), supermarkets (36%), and wet markets (22%). Sampling covered five of six of Colombia's SESs. Samples from stratum 1 (the lowest in the scale) were not collected due to distance and security concerns. Overall, 43% of the samples were from stratum 2; 40% were from stratum 3; and 13, 3, and 1% were from strata 4, 5, and 6, respectively. The largest percentage of samples (89%) were associated with conventional commercial chickens (versus independent free-range chickens), and 55% were frozen (versus chilled) chickens. The mean price per carcass was US$4.9 (±1.4).

Prevalence of *Salmonella* and risk factor analysis. Overall *Salmonella* prevalence was 27% ($n = 1{,}003$ broiler carcasses). The *Salmonella* prevalence ranged from 0 to 57% among the cities (Table 1). There were significant differences ($P < 0.05$) in *Salmonella* prevalences by (i) storage condition (42% on chilled versus 14% on frozen chickens) and (ii) poultry company (23% on chickens from integrated companies versus 37% from nonintegrated companies). There were no significant differences in the prevalence of *Salmonella* contamination ($P > 0.05$) by (i) type of retail store (26% in supermarket, 26% in independent stores, and 30% in wet market), (ii) chicken production system (35% on free-range versus 26% on conventional chickens), and (iii) SES (31, 29, 23, 35, and 8% in strata 2, 3, 4, 5, and 6, respectively) (Table 3).

DISCUSSION

The overall *Salmonella* prevalence of 27% on broiler chicken meat determined in this study is consistent with the prevalence of 26% reported in a cross-sectional study of retail chicken meat conducted in Bogotá in 2010 *(7)*. A comparison of our study results to data from other countries showed that the prevalence of *Salmonella* on raw retail chickens in Colombia was higher than those reported in the United Kingdom *(16),* New Zealand *(26),* and the United States *(29),* in which prevalences of 4% ($n = 877$), 3% ($n = 232$), and 4.2% ($n = 212$), respectively, have been recently reported. The *Salmonella* prevalence on raw retail

TABLE 3. *Logistic regression analysis for potential risk factors related to prevalence of* Salmonella *on broiler chicken carcasses at retail stores*

Variable	No. (%) of *Salmonella*-positive samples	Odds ratio	*P* value[a]
Chicken production system			
Free-range	37 (35)	1.5	0.051
Conventional	233 (26)		
Storage condition			
Chilled	191 (42)	4.3	<0.001
Frozen	79 (14)		
Poultry company			
Integrated company	158 (23)	2.0	<0.001
Nonintegrated company	112 (37)		
Retail store type			
Wet market[b]	67 (30)		
Supermarket	94 (26)	0.8	0.287
Independent	109 (26)	0.8	0.246
SES			
2[b]	113 (31)		
3	98 (29)	0.9	0.488
4	25 (23)	0.7	0.104
5	9 (35)	1.2	0.705
6	1 (8.0)	0.2	0.128

[a] *P* values were based on logistic regression models in STATA software to assess *Salmonella* prevalence association with potential risk factors (*P* values of <0.05 were considered significantly different).

[b] Wet market and SES 2 were the referent groups in the logistic regression models for retail store type and SES risk factors, respectively.

chicken in Colombia was lower than those reported in Portugal (60%, $n = 60$) *(1),* Belgium (36%, $n = 772$) *(24),* Australia (43.3%, $n = 859$) *(22),* and Spain (35.8%, $n = 198$) *(6)*. In Latin America, the reported *Salmonella* prevalence on raw retail chicken was 20% ($n = 20$) in Argentina *(12)* and 42% ($n = 100$) in Brazil *(10)*. In Southeast Asia, relatively higher *Salmonella* prevalences were reported for retail chickens in Vietnam (53.3%, $n = 30$) *(25),* China (52.2%, $n = 1{,}152$) *(28),* and Thailand (57%, $n = 72$) *(18)*. The differences in *Salmonella* prevalence among these studies could be attributed to differences in sampling scheme or design, sample type (whole chicken versus chicken parts and chilled versus frozen chickens), the *Salmonella* detection protocol, and chicken production systems and companies (conventional versus organic and/or free-range raising practices, and integrated versus nonintegrated companies).

Our findings of a lower prevalence of *Salmonella* on chickens stored frozen compared with chilled are in agreement with several studies that identified storage temperature as an important risk factor of pathogen survival and growth *(17)*. Fluctuation in the chilling temperature might have contributed to the higher *Salmonella* prevalence on chilled chickens. Similarly, thawing frozen chickens might have reduced *Salmonella* prevalence on the carcasses.

The lower *Salmonella* prevalences on chickens from integrated poultry companies could be associated with the implementation of recent poultry regulations, including hazard analysis and critical control points (HACCP) systems in Colombia *(14, 19)*. Furthermore, integrated poultry companies in Colombia manage the entire poultry production and processing chain (feed mills to chicken processing), which can enhance the food safety system and the sanitary quality of the final product.

Interestingly, the type of retail store was not determined to be a risk factor, which is in agreement with other studies *(16, 21, 29)* whereby no associations were found between the type of retail store and the prevalence of *Salmonella*. A study in the United Kingdom in 2005 revealed *Salmonella* prevalence of 4.5% ($n = 614$) and 2.2% ($n = 263$) on chickens from retailers and local butcheries, respectively; however, these differences were not significant *(16)*. A recent study conducted in China with 1,152 whole chicken carcass samples collected and analyzed for *Salmonella* by a methodology similar to that used in our study revealed no significant differences among *Salmonella* prevalences on raw chicken from wet, small, and large retail markets *(28)*.

A *Salmonella* prevalence of 27% on retail chickens in Colombia indicates that there are still opportunities to reduce the presence of this pathogen on chicken products and the potential for human illness. The risk factors that we found are consistent with those from other international studies *(4, 17, 28)*. These outcomes could be useful to the Colombian poultry industry and policy makers to further strengthen the food safety system along the poultry production, processing, and marketing chain to reduce the prevalence of *Salmonella*.

Chicken meat is a vehicle for transmitting *Salmonella* to humans. Our findings revealed that the higher *Salmonella* prevalence on raw chicken meat at retail in Colombia could be associated with nonintegrated companies and storage at chilled temperatures. Strategies to reduce the prevalence of *Salmonella* on raw chicken and reduce the risk of human salmonellosis include good agriculture and management practices, better hygienic conditions, implementation of HACCP in the entire poultry production, processing, and marketing chain, and improvement of food safety consumer education for handling raw poultry *(15)*.

ACKNOWLEDGMENTS

The research work was supported by the project ''Data Collection for *Salmonella* in Raw Poultry in Colombia'' of the University of Georgia, in collaboration with the WHO Global Foodborne Infections Network (GFN). We thank Dr. Enrique Perez from PAHO-WHO for facilitating the connection between the research groups that worked on this project. We thank Dr. Naila Baig-Ansari, consultant epidemiologist, for her advice in finalizing the manuscript.

REFERENCES

1. Antunes, P., C. Reu, J. C. Sousa, L. Peixe, and N. Pestana. 2003. Incidence of *Salmonella* from poultry products and their susceptibility to antimicrobial agents. *Int. J. Food Microbiol.* 82:97–103.
2. Blas, N., C. Ortega, K. Frankena, K. Noordhuizen, and M. Thrusfield. 2000. Win Episcope 2.0, EPIDECON, Borland ® Delphi™. Available at: http://www.clive.ed.ac.uk/cliveCatalogueItem.asp?id=B6BC9009-C10F-4393-A22D-48F436516AC4. Accessed 1 November 2011.
3. Centers for Disease Control and Prevention. 2008. Annual listing of foodborne disease outbreaks. Outbreak surveillance data. Reported foodborne disease outbreaks and illnesses by etiology and food commodities, United States. Available at: http:www.cdc.gov/foodborneoutbreaks/outbreak_data.htm. Accessed 1 November 2011.
4. Cui, S., B. Ge, J. Zheng, and J. Meng. 2005. Prevalence and antimicrobial resistance of *Campylobacter* spp. and *Salmonella* serovars in organic chickens from Maryland retail stores. *Appl. Environ. Microbiol.* 71:4108–4111.
5. Departamento de Planeacion Nacional. 2007. Conpes 3468. Politica Nacional de Sanidad de Inocuidad para la Cadena Avicola Colombiana. Bogota, Colombia.
6. Dominguez, C., I. Gomez, and J. Zumalacarregui. 2002. Prevalence of *Salmonella* and *Campylobacter* in retail chicken meat in Spain. *Int. J. Food Microbiol.* 72:165–168.
7. Donado-Godoy, P. 2010. Prevalence, resistance patterns and risk factors for antimicrobial resistance in poultry farms and retail chicken meat in Colombia and molecular characterization of *Salmonella* Paratyphi B and *Salmonella* Heidelberg. Ph.D. dissertation. University of California, Davis.
8. Fenavi. 2009. Consumo per capita en el mundo y en Colombia. Available at: http://www.fenavi.org/fenavi/consumo-per-capita2.php?idm=42. Accessed 7 September 2011.
9. Flint, J. A., Y. T. Van Duynhoven, F. J. Angulo, S. M. DeLong, P. Braun, M. Kirk, E. Scallan, M. Fitzgerald, G. K. Adak, P. Sockett, A. Ellis, G. Hall, N. Gargouri, H. Walke, and P. Braam. 2005. Estimating the burden of acute gastroenteritis, foodborne disease, and pathogens commonly transmitted by food: an international review. *Clin. Infect. Dis.* 41:698–704.
10. Fuzihara, T. O., S. A. Fernandes, and B. D. Franco. 2000. Prevalence and dissemination of *Salmonella* serotypes along the slaughtering process in Brazilian small poultry slaughterhouses. *J. Food Prot.* 63: 1749–1753.
11. Hanning, I. B., J. D. Nutt, and S. C. Ricke. 2009. Salmonellosis outbreaks in the United States due to fresh produce: sources and potential intervention measures. *Foodborne Pathog. Dis.* 6:635–648.
12. Jimenez, S. M., M. S. Salsi, M. C. Tiburzi, and M. E. Pirovani. 2002. A comparison between broiler chicken carcasses with and without visible faecal contamination during the slaughtering process on hazard identification of *Salmonella* spp. *J. Appl. Microbiol.* 93:593–598.

13. Kang, Z. W., J. H. Jung, S. H. Kim, B. K. Lee, D. Y. Lee, Y. J. Kim, J. Y. Lee, H. K. Won, E. H. Kim, and T. W. Hahn. 2009. Genotypic and phenotypic diversity of *Salmonella Enteritidis* isolated from chickens and humans in Korea. *J. Vet. Med. Sci.* 71:1433–1438.
14. Leon, J., S. Diazgranados, J. F. Lozano, and A. Uriel. 2007. Decreto No 1500 de 2007. Ministerio de la Proteccion Social, Bogota, Colombia.
15. Mead, G., A. M. Lammerding, N. Cox, M. P. Doyle, F. Humbert, A. Kulikovskiy, A. Panin, V. P. do Nascimento, and M. Wierup. 2010. Scientific and technical factors affecting the setting of *Salmonella* criteria for raw poultry: a global perspective. *J. Food Prot.* 73:1566–1590.
16. Meldrum, R. J., and I. G. Wilson. 2007. *Salmonella* and *Campylobacter* in United Kingdom retail raw chicken in 2005. *J. Food Prot.* 70:1937–1939.
17. Oscar, T. P. 2004. A quantitative risk assessment model for *Salmonella* and whole chickens. *Int. J. Food Microbiol.* 93:231–247.
18. Padungtod, P., and J. B. Kaneene. 2006. *Salmonella* in food animals and humans in northern Thailand. *Int. J. Food Microbiol.* 108:346–354.
19. Palacio-Betancur, D. 2007. Resolución 42807 de 2007. Ministerio de la Protección Social, Bogota, Colombia.
20. Pires, S. M., A. R. Vieira, E. Perez, D. L. F. Wong, and T. Hald. 2012. Attributing human foodborne illness to food sources and water in Latin America and the Caribbean using data from outbreak investigations. *Int. J. Food Microbiol.* 152:129–138.
21. Plummer, R. S., S. J. Blissett, and C. Dodd. 1995. *Salmonella* contamination of retail chicken products sold in the United Kingdom. *J. Food Prot.* 58:843–846.
22. Pointon, A., M. Sexton, P. Dowsett, T. Saputra, A. Kiermeier, M. Lorimer, G. Holds, G. Arnold, D. Davos, B. Combs, S. Fabiansson, G. Raven, H. McKenzie, A. Chapman, and J. Sumner. 2008. A baseline survey of the microbiological quality of chicken portions and carcasses at retail in two Australian states (2005 to 2006). *J. Food Prot.* 71:1123–1134.
23. U.S. Department of Agriculture. 2008. Laboratory guidebook: isolation and identification of *Salmonella* from meat, poultry, and egg products, p. 1–14. U.S. Department of Agriculture, Washington, DC.
24. Uyttendaele, M., P. De Troy, and J. Debevere. 1999. Incidence of *Salmonella, Campylobacter jejuni, Campylobacter coli,* and *Listeria monocytogenes* in poultry carcasses and different types of poultry products for sale on the Belgian retail market. *J. Food Prot.* 62:735–740.
25. Van, T. T., G. Moutafis, T. Istivan, L. T. Tran, and P. J. Coloe. 2007. Detection of *Salmonella* spp. in retail raw food samples from Vietnam and characterization of their antibiotic resistance. *Appl. Environ. Microbiol.* 73:6885–6890.
26. Wong, T. L., C. Nicol, R. Cook, and S. MacDiarmid. 2007. *Salmonella* in uncooked retail meats in New Zealand. *J. Food Prot.* 70:1360–1365.
27. World Health Organization. 2005. Drug-resistant *Salmonella*. Fact sheet no. 139. Available at: http://www.who.int/mediacentre/factsheets/fs139/en/. Accessed 8 September 2011.
28. Yang, B., M. Xi, X. Wang, S. Cui, T. Yue, H. Hao, Y. Wang, Y. Cui, W. Q. Alali, J. Meng, I. Walls, D. M. Wong, and M. P. Doyle. 2011. Prevalence of *Salmonella* on raw poultry at retail markets in China. *J. Food Prot.* 74:1724–1728.
29. Zhao, C., B. Ge, J. De Villena, R. Sudler, E. Yeh, S. Zhao, D. G. White, D. Wagner, and J. Meng. 2011. Prevalence of *Campylobacter* spp., *Escherichia coli*, and *Salmonella* serovars in retail chicken, turkey, pork, and beef from the Greater Washington, DC, area. *Appl. Environ. Microbiol.* 67:5431–5436.