

## Research Note

# Salmonella Serotypes Isolated from Nonhuman Sources in São Paulo, Brazil, from 1996 through 2000

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### ABSTRACT

A total of 4,581 *Salmonella* strains isolated from nonhuman sources, including foodstuffs associated with foodborne *Salmonella* outbreaks, from January 1996 through December 2000 were serotyped at the Enteropathogens Laboratory, Instituto Adolfo Lutz, São Paulo, Brazil. Among the 123 different serotypes identified, *Salmonella enterica* subsp. *enterica* serotype Enteritidis (*Salmonella* Enteritidis) was the most prevalent (32.7%), ranking first for almost every kind of source. The next most common serotypes were *Salmonella* Senftenberg (10.3%), *Salmonella* Hadar (6.8%), *Salmonella* Agona (5.1%), and *Salmonella* Typhimurium (2.4%). Rough strains belonging to the subspecies *S. enterica* subsp. *enterica* (4.8%), *S. enterica* subsp. *arizonae* (<1%), *S. enterica* subsp. *diarizonae* (<1%), and *S. enterica* subsp. *houtenae* (<1%) were also detected. Foodstuffs (including poultry meat for consumption) contained 38.1% of the studied *Salmonella* strains, poultry flocks (from several farms under salmonellosis control by the owners) contained 21.7%, the environment contained 10.6%, sewage contained 9.4%, water contained 6.6%, animal feed contained 4.4%, chill water from poultry-processing operations contained 2.2%, and other sources contained 7.0%. Foodstuffs extensively contaminated with *Salmonella* strains were poultry meat (40%), cow meat (11%), desserts (8%), mayonnaise (6%), sausage (5%), and unpasteurized shell eggs (4%), and there were several other food sources (26%). Homemade mayonnaise was the most common vehicle for *Salmonella* foodborne outbreaks, and *Salmonella* Enteritidis was the serotype most isolated (95%) from that source. According to these data and previously published data concerning *Salmonella* strains isolated in São Paulo State, almost the same serotypes have predominated among nonhuman sources for the last decade.

*Salmonellae* are zoonotic enterobacteria that are responsible for outbreaks of both human and animal clinical diseases and have important worldwide hygienic and economic significance. There are several transmission routes for salmonellosis, but the majority of human infections are derived from the consumption of contaminated foods (especially those of animal origin) and water (19). International or multistate outbreaks caused by a range of foodstuffs contaminated with different *Salmonella* serotypes have been reported (3–5, 11, 13, 15).

Although *Salmonella* strains may be isolated from a wide range of sources and animal reservoirs, poultry are the most important reservoir, particularly for *Salmonella enterica* subsp. *enterica* serotype Enteritidis (*Salmonella* Enteritidis). This serotype and several others have often been associated with foodborne outbreaks and/or sporadic cases of human salmonellosis and have often been isolated from foodstuffs of animal origin and other sources. Raw eggs and raw-egg-containing foods and poultry and other

meats are the foods of animal origin that have most commonly been implicated in such infections (3–5, 11, 13, 19).

*Salmonella* Enteritidis has been reported to be the main cause of foodborne *Salmonella* outbreaks in several developed countries over the last 3 decades (5, 12, 13). In Brazil, this serotype started spreading in 1993, being largely isolated from poultry sources, and thereafter became the prevailing serotype for human salmonellosis, particularly in foodborne outbreaks but also in outbreaks attributable to different nonhuman sources (1, 10, 16, 18).

An important role of a public health laboratory is to contribute to salmonellosis surveillance by reporting data from *Salmonella* serotyping, which is the important initial step in the detailed characterization of *Salmonella* strains. Thus, this study was carried out to evaluate the distribution and prevalence of *Salmonella* serotypes isolated from nonhuman materials, including foodstuffs associated with foodborne outbreaks and those not associated with foodborne outbreaks, from 1996 through 2000 in São Paulo State, Brazil.

### MATERIALS AND METHODS

A total of 4,581 *Salmonella* strains isolated from nonhuman sources from January 1996 through December 2000 were sero-

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pasteurized shell eggs, around 60% were *Salmonella* Enteritidis strains.

*Salmonella* Hadar, the third most prevalent serotype in this study and the fifth most prevalent from 1991 through 1995 (18), was extensively detected in poultry meat, particularly carcasses, as well as in isolates from chill water used for processing of these carcasses. This finding is in agreement with those of previous reports describing the presence of this serotype in such sources, as well as in connection with foodborne outbreaks (2, 7).

*Salmonella* Agona, one of the most prevalent serotypes until the beginning of the 1990s (17), was isolated mostly from sewage samples, despite its presence in the majority of the different sources over the period studied. These data indicate the steady circulation of this important serotype through the years. The detection of the other 34 serotypes in sewage, even without periodic monitoring of this source with regard to the presence of *Salmonella* spp., corroborates the importance of proper sanitation of this significant contamination vehicle.

Four of the 10 serotypes most commonly found in non-human sources, *Salmonella* Enteritidis, *Salmonella* Agona, *Salmonella* Typhimurium, and *Salmonella* Infantis, were also among the top 10 serotypes associated with human disease over the period under study. On the other hand, almost 80 different serotypes have been found at different incidences in material of nonhuman origin but not in human infection isolates.

Apart from the 123 different serotypes identified in this study, rough (serologically untypeable) strains belonging to the subspecies *S. enterica* subsp. *enterica* (4.8%), *S. enterica* subsp. *arizonae* (<1%), *S. enterica* subsp. *diarizonae* (<1%), and *S. enterica* subsp. *houtenae* (<1%) were also identified. In addition, some changes in normal biochemical characteristics displayed by *Salmonella* spp. were detected in a few strains, such as lysine decarboxylase-negative *Salmonella* Emek and sucrose-fermenting *Salmonella* Idikan and *S. enterica* subsp. *enterica* 54:-:-. Such strains probably survived under high environmental stress, which could explain these findings.

It often happens that the list of different *Salmonella* serotypes detected in a specific region increases with the addition of some serotypes that had not been detected yet. Five serotypes, namely *Salmonella* Bracknell, *Salmonella* Uccle, sucrose-fermenting *Salmonella* Idikan, *S. enterica* subsp. *diarizonae* 60:r:e,n,x,z<sub>15</sub>, and *S. enterica* subsp. *diarizonae* 65:z<sub>53</sub>:k, were isolated for the first time from non-human sources in our geographic area.

Studies focusing on the determination of the prevalent serotypes in a region, particularly those associated with foodborne outbreaks, allow further detailed characterization of such serotypes. The results of such studies provide information for tracing the vehicle origin, which could distinguish local outbreaks from widespread outbreaks (11, 15). Thus, the characterization of *Salmonella* Enteritidis by other phenotypic and molecular methods has been applied in our laboratory (8, 9).

By comparing the results of the present study with those of previous studies (18), it can be seen that over the

last decade, almost the same *Salmonella* serotypes have predominated among nonhuman isolates in São Paulo State. These results also provide a baseline for future comparisons for *Salmonella* epidemiological surveillance.

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## REFERENCES

1. Araújo, E., M. A. S. R. Pacheco, R. F. Boni, Y. S. K. Fonseca, D. S. Gelli, S. A. Fernandes, and A. T. Tavechio. 1995. Surto alimentares por *Salmonella* Enteritidis, associados ao consumo de alimentos à base de ovos, em Sorocaba, SP. Hig. Alimentar 9(40):24–26.
2. Bisbini, P., E. Leoni, and A. Nanetti. 2000. An outbreak of *Salmonella* Hadar associated with roast rabbit in a restaurant. Eur. J. Epidemiol. 16:613–618.
3. Centers for Disease Control and Prevention. 1998. Multistate outbreak of *Salmonella* serotype Agona infections linked to toasted oats cereal—United States, April–May, 1998. Morb. Mortal. Wkly. Rep. 47:462–464.
4. Centers for Disease Control and Prevention. 1999. Outbreak of *Salmonella* serotype Muenchen infections associated with unpasteurized orange juice—United States and Canada, June 1999. Morb. Mortal. Wkly. Rep. 48:582–585.
5. Centers for Disease Control and Prevention. 2000. Outbreaks of *Salmonella* serotype Enteritidis infection associated with eating raw or undercooked shell eggs—United States, 1996–1998. Morb. Mortal. Wkly. Rep. 49:73–79.
6. Ewing, W. H. 1986. Edwards and Ewing's identification of *Enterobacteriaceae*, 4th ed. Elsevier Science Publishing Co., New York.
7. Faustini, A., M. Sangalli, M. Fantasia, R. Manganello, E. Mattacini, R. Tripanera, D. Spera, U. La Rosa, M. T. Topi, F. Forastiere, and C. A. Perucci. 1998. An outbreak of *Salmonella hadar* associated with food consumption at a building site canteen. Eur. J. Epidemiol. 14:99–106.
8. Fernandes, S. A., A. T. Tavechio, A. C. R. Ghilardi, G. R. F. Valle, and K. Irino. 1997. Caracterização molecular de cepas de *Salmonella* Enteritidis isoladas no estado de São Paulo. Pôster MH140, p. 75. In Resumos do XIX Congresso Brasileiro de Microbiologia. Sociedade Brasileira de Microbiologia, Rio de Janeiro, Brazil.
9. Irino, K., S. A. Fernandes, A. T. Tavechio, B. C. Neves, and A. M. G. Dias. 1996. Progression of *Salmonella* Enteritidis phage type 4 strains in São Paulo State, Brazil. Rev. Inst. Med. Trop. São Paulo 38:193–196.
10. Kaku, M., J. T. M. Peresi, A. T. Tavechio, S. A. Fernandes, A. B. Batista, I. A. Z. Castanheira, G. M. P. Garcia, K. Irino, and D. S. Gelli. 1995. Surto alimentar por *Salmonella* Enteritidis no noroeste do estado de São Paulo, Brasil. Rev. Saude Publica 29:127–131.
11. Mahon, B. E., A. Pönkä, W. N. Hall, K. Komatsu, S. E. Dietrich, A. Siitonen, G. Cage, P. S. Hayes, M. A. Lambert-Fair, N. H. Bean, P. M. Griffin, and L. Slutsker. 1997. An international outbreak of *Salmonella* infections caused by alfalfa sprouts grown from contaminated seeds. J. Infect. Dis. 175:876–882.
12. Nastasi, A., and C. Mammina. 1996. Epidemiology of *Salmonella enterica* serotype Enteritidis infections in southern Italy during the years 1980–1994. Res. Microbiol. 147:393–403.
13. Nylen, G., H. M. P. Fielder, and S. R. Palmer. 1999. An international outbreak of *Salmonella enteritidis* associated with lasagne: lessons on the need for cross-national co-operation in investigating foodborne outbreaks. Epidemiol. Infect. 123:31–35.
14. Popoff, M. Y., and L. Le Minor. 1997. Formules antigéniques des sérovars de *Salmonella*. Centre Collaborateur OMS de Référence et de Recherche pour les *Salmonella*, Institut Pasteur, Paris.
15. Puohiniemi, R., T. Heiskanen, and A. Siitonen. 1997. Molecular epidemiology of two international sprout-borne *Salmonella* outbreaks. J. Clin. Microbiol. 35:2487–2491.
16. Santos, S. M., and E. Kupek. 2000. Serial outbreaks of food-borne

- disease in Blumenau, Brazil, caused by *Salmonella enteritidis*. *Braz. J. Infect. Dis.* 4:275–278.
17. Taunay, A. E., S. A. Fernandes, A. T. Tavechio, B. C. Neves, A. M. G. Dias, and K. Irino. 1996. The role of public health laboratory in the problem of salmonellosis in São Paulo, Brazil. *Rev. Inst. Med. Trop. São Paulo* 38:119–127.
  18. Tavechio, A. T., S. A. Fernandes, B. C. Neves, A. M. G. Dias, and K. Irino. 1996. Changing patterns of *Salmonella* serovars: increase of *Salmonella* Enteritidis in São Paulo, Brazil. *Rev. Inst. Med. Trop. São Paulo* 38:315–322.
  19. World Health Organization. 1983. Guidelines on prevention and control of Salmonellosis. World Health Organization, Geneva.