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SHORT REPORT
Prevalence of *Escherichia coli* and *Salmonella* spp. in street-vended food of open markets (*tianguis*) and general hygienic and trading practices in Mexico City

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SUMMARY

Street-vendors in Mexico City provide ready-to-eat food to a high proportion of the inhabitants. Nevertheless, their microbiological status, general hygienic and trading practices are not well known. During spring and summer 2000, five *tianguis* (open markets) were visited and 48 vendors in 48 stalls interviewed. A total of 103 taco dressings were sampled for *E. coli* and *Salmonella* spp.: 44 (43%) contained *E. coli* and 5 (5%) *Salmonella* (2 *S.* Enteritidis phage type 8, 1 *S.* Agona, 2 *S.* B group). Both *E. coli* and salmonellas were isolated from three samples. Of *Salmonella*-positive stalls 80% (4/5) had three or more food-vendors and 80% of vendors were males, compared with 37·3% (16/43) and 46·4% (20/43) in the *Salmonella*-negative stalls respectively. Food-vendors kept water in buckets (reusing it all day), lacked toilet facilities, and prepared taco dressings the day before which remained at the *tianguis* without protection for 7·8 h on average. Consumption of street-vended food by local and tourist populations poses a health risk.

Street-vended food offers a variety of fast ready-to-eat foods and beverages sold and sometimes prepared in public places, offering consumers low-priced food close to their working place, and also jobs to an otherwise unemployed population [1]. In many developing countries including Mexico, street-vended food is a major source of fast ready-to-eat meals for a large proportion of the population [1]. Two studies [2, 3] of the microbiological status of street-vended food showed that it contained human faecal pathogens in sufficient quantity to cause disease. Moreover, it has been associated with traveller's diarrhoea [4–7].

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Tianguis, a Nahuatl (the Aztecs' original language) word for an open-street market [8] have existed since pre-Columbian times [9] in almost every Mexican town. We evaluated the prevalence of *E. coli* and *Salmonella* serotypes in street-vended taco dressings sold in the *tianguis* of Mexico City, and attempted to identify any poor hygiene practices.

This study was performed in five different *tianguis* of Mexico City's southern suburbs during spring and summer of 2000. These *tianguis* were visited weekly during each season, stalls randomly selected and the general conditions and environmental temperatures registered. Samples of taco dressings were collected at the same time each day. All 48 food-handlers were interviewed regarding place and time of food preparation, water and toilet facilities. We noted the

Table. *Taco-dressing samples that contained* E. coli *and* Salmonella *their collection season and c.f.u./g*

		Spring			Summer		
No. of samples*	Taco dressing	No. of *E. coli* samples	*E. coli* c.f.u./g range	No. of *Salmonella* samples	No. of *E. coli* samples	*E. coli* c.f.u./g range	No. of *Salmonella* samples
8	Raw red chili sauce	—	—	1, *S.* Enteritidis†	2	1×10^2 and $2{\cdot}8 \times 10^3$	—
28	Boiled red chili sauce	4	$4{\cdot}8 \times 10^2$ to $1{\cdot}2 \times 10^5$	—	4	$1{\cdot}4$–$4{\cdot}2 \times 10^3$	—
5	Raw green chili sauce	2	8×10^1 and $5{\cdot}4 \times 10^4$	—	1	6×10^2	—
26	Boiled green chili sauce	3	5×10^1 to $8{\cdot}8 \times 10^3$	1, *S.* Enteritidis† 1, *S.* B gp.	4	2×10^2 to $7{\cdot}1 \times 10^4$	—
11	Raw pico de gallo	3	$1{\cdot}1 \times 10^3$ to $2{\cdot}8 \times 10^6$	—	4	$3{\cdot}6 \times 10^2$ to $1{\cdot}5 \times 10^5$	—
9	Raw coriander	2	$1{\cdot}6 \times 10^3$ and $1{\cdot}8 \times 10^5$	—	4	$1{\cdot}5 \times 10^2$ to 1×10^5	—
7	Raw onion	1	$6{\cdot}4 \times 10^6$	—	2	$1{\cdot}2$ and $7{\cdot}5 \times 10^6$	—
5	Raw coriander onion mix	2	$1{\cdot}3$ and $2{\cdot}5 \times 10^4$	1, *S.* B gp.	3	1×10^3 to $1{\cdot}1 \times 10^6$	1, *S.* Agona
3	Raw guacamole	—	—	—	2	$8{\cdot}8 \times 10^2$ and $4{\cdot}6 \times 10^6$	

* For one green chili sauce the vendor did not specify if the sauce was raw or boiled.
† Both *S.* Enteritidis were phage type 8.

stand's general hygienic conditions, number of street-vendors per stand and vendor's gender. Forty-eight stalls were visited and 103 taco-dressing samples were collected, 50 in spring and 53 in summer: 36 red chili sauces, 32 green chili sauces, 11 'pico de gallo', 3 'guacamole', 9 coriander, 7 onion and 5 coriander–onion mix (see Table). The pH was determined and 1 g taken from each sample. Dilutions were prepared in sterile saline solution 0·85% (Research Organics, Cleveland, OH, USA), 100 μl of each sample and their respective dilutions were placed on MacConkey agar and incubated at 37 °C for 24 h. *E. coli*-like colonies were counted and biochemically characterized. For *Salmonella*, 100 μl of each sample and their respective dilutions were placed on bismuth sulphite (Bioxon, Becton Dickinson, Mexico) agar plate and incubated at 37 °C for 24 and 48 h. For enrichment, 500 μl of each sample was added to tetrathionate broth (Difco, Detroit, MI, USA) and incubated at 37 °C for 18 and 24 h. After incubation, 100 μl of each sample were placed on a bismuth sulphite agar plate and processed as above. From all plates, *Salmonella*-like colonies (metallic dark-green with dark halo colonies) were selected and characterized using standard biochemical and serological techniques [10]. *S.* Enteritidis strains were further characterized by phage-typing techniques [11].

The pH of chili sauces (green, red and pico de gallo) was in the range of 4–5, guacamole 4–7, coriander 6–7. For all onion and coriander–onion mix samples, the pH was 6·0. The average environmental temperature during sampling was 26 °C. Fifty per cent (24/48) of street-vendors were male, 54% (26) had attended school for 9 years or more, and 56% (27/48) of the stalls had one or two vendors. Forty-three per cent (44/103) of taco dressings were contaminated with *E. coli* (Table). The pH of these sauces ranged from 4 to 7. More *E. coli*-contaminated samples were collected in summer 61% (27) than in spring 39% (17). No differences in any variables examined were observed between the *E. coli*-positive and negative stalls. Five out of 103 (5%) samples were positive for *Salmonella* (Table), three of which also grew *E. coli*. In 4 out of 5 (80%) of the *Salmonella*-positive stalls, the food-vendors were males and 4 out of 5 (80%) had three or more vendors compared with the *Salmonella*-negative stalls: 20 out of 43 (46·4%) and 16 out of 43 (37·3%) respectively. The 48 stalls kept water in buckets for rinsing hands and tableware, reusing the same water several times during the day.

In 94% (45/48) of the stalls, buckets were filled with tap water: in four of these stalls the water was chlorinated (vendors stated adding two drops of commercial bleach per litre of water) and in two boiled. Only in 6% (3) was bottled water used instead of tap water. Street-vendors stated that they lacked proper toilet facilities (running water, soap, toilet paper). Most food handlers 45 out of 48 (94%) acknowledged receiving at least one food-safety course from the local health authorities (including 95% from the *E. coli*-positive and all the *Salmonella*-positive stalls), 92% (44) prepared taco dressings at home the day before, and only 10% (5) reused leftovers. Food items remained without protection, exposed for 5–8 h (average 7·8 h) to the street environment while in the *tianguis*.

This work demonstrates that street-vended taco dressings in Mexico City's *tianguis*, harbour *E. coli* and *Salmonella* spp. Two reports [3, 12] have shown that chili sauces in Mexico can harbour diarrhoeagenic *E. coli* strains in sufficient quantity to cause disease. Diarrhoeagenic *E. coli* [13] and *Salmonella* have also been found in street-vended food in African countries [13–15] and *Salmonella* contamination in Latin America and Mexico [2]. The *Salmonella* serotypes found (Table) have been associated with foodborne outbreaks worldwide [16–19], including Mexico [20]. *S.* Enteritidis and *E. coli* were isolated from 2 and 18 samples respectively, all with pH of 4·0. Thus the perception that low pH protects against bacterial food contamination does not seem valid for *E. coli* and *S.* Enteritidis, compared with other enteric bacteria such as *Vibrio cholerae*, whose growth is clearly inhibited at pH 5·0 [21].

Some of the raw vegetables used in the dressings (see Table) were possibly contaminated in the farm. The fact that boiled chili sauces harboured *E. coli* and *Salmonella* spp. implies that they were contaminated after preparation [22–26], suggesting inappropriate handling.

Our study demonstrates the poor general sanitary conditions of street-food handling and trading in Mexico City. Further studies are needed to quantify this risk not only in Mexico but also in other countries with fast-food street markets. These should focus on identifying practices which increase the risk of food contamination, and on implementing measures to improve the sanitary conditions of trading. Simple intervention strategies can have a sound practical impact on public health. Hand washing with soap apparently reduces the risk of diarrhoea by 42–47% [27]. For water and street-vended beverages, a simple system for water purification and storage [28] should be mandatory. Educational campaigns for consumers, and food-safety courses for food handlers should aim at reducing identified risks. Follow-up visits after intervention are important to assess the impact of preventive measures [28].

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