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SHORT PAPER

Faecal contamination and enterotoxigenic *Escherichia coli* in street-vended chili sauces in Mexico and its public health relevance

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SUMMARY

The street-vended food industry provides employment and cheap ready-to-eat meals to a large proportion of the population in developing countries like Mexico, yet little is known about its role in the transmission of food borne diseases (FBD). Because of its wide consumption, street-vended chili sauces in Mexico are potential vehicles of FBD. An observational study was performed in Mexico City collecting 43 street-vended chili sauces. These sauces were prepared under poor hygienic conditions of handling and selling. Consumers add 4–8 ml of chili sauce per taco, ingest 2–5 tacos per meal and on average, 50 consumers frequent a stall per day. Seventeen (40%) samples were faecally contaminated and 2(5%) sauces harboured sufficient enterotoxigenic *Escherichia coli* to cause disease. We estimate that the consumption of only one of these chili sauces could result in ETEC disease in at least 21000 consumers per year, making them important potential vehicles of FBD.

Economic 'adjustments' have dramatically increased the 'informal economy' in Mexico. During 1993–8 this sector employed 28·5% of the labour force, generating 12·7% of the national gross product, with 30·8% of its commercial activity in street-vended food [1]. Conservative estimates suggest that the latter provides employment to at least 120000 street-food vendors in Mexico City alone [2]. In addition, this industry provides, especially in large cities, cheap ready-to-eat meals close to the work place of a large proportion of the population, mostly the poor or middle class. Although practically absent in industrialized countries, street-vended food must be considered when assessing the impact of food borne disease (FBD) in developing countries. Food safety and FBD are increasingly important public health issues worldwide. In the USA, FBD causes approximately 76 million illnesses, 325000 hospitalizations and 5000 deaths [3]. Certain food items make excellent vehicles of disease as the infectious dose needed to cause illness is greatly reduced when the organisms are ingested together with food but not with water. Such is the case with *Vibrio cholerae* [4] where, in order to produce high attack rates of cholera, normal volunteers need to ingest as many as 10^{11} cholera vibrios in water. In contrast, when the stomach acid is neutralized or vibrios are ingested with certain food items, the infectious dose is reduced to as low as 10^{2}–10^{3} organisms.

Chili sauce consumption in Mexico has ancient precolumbian roots [5] and it is a traditional dressing of most typical street-vended meals. The sauces are made of several ingredients including chili, onion, red and green tomatoes, and coriander. The ingredients can be raw or cooked. Chili has been used since precolumbian times for popular healing preparations,

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Table 1. *Frequency and toxigenicity of* Escherichia coli *in chili sauces samples* (n = *43*) *sold on the street*

Faecally contaminated samples 17 (40%)				ETEC contaminated samples 2 (5%)		
Chili sauce type	Positive samples	CFU/g range	CFU/g mean	Chili sauce type	CFU/g	Positive LT/ST strains
Green sauce	12	$2–1300 \times 10^2$	177×10^2	Green sauce	$7{\cdot}6 \times 10^3$	5/5
Red sauce	5	$4–300 \times 10^2$	74×10^2	Green sauce	$1{\cdot}3 \times 10^4$	5/5

for stomachache and treatment of cough [5]. Even today, it is widely believed that chili consumption is beneficial for nasal decongestion, as an antiseptic or even against some diarrhoeal diseases. Furthermore, it has been documented that some chili species (*Capsicum* spp.) [6] or their alkamide capsaicin [7] display antimicrobial activity against some Gram-positive bacteria, namely *Bacillus cereus*, *B. subtilis*, *Clostridium tetani*, and *C. sporogenes*, and on *Escherichia coli* and *Ralstonia* (*Pseudomonas*) *solanacearum*.

Enterotoxigenic *E. coli* (ETEC) is the leading cause of weanling diarrhoea in developing countries and of travellers' diarrhoea around the world [8]. It is estimated that ETEC in children under age 5 years cause 400 million cases and 700 thousand deaths per year world wide [9], the main vehicles of transmission being water and food [8]. Several studies have shown the importance of ETEC in infant [10,11] and travellers' diarrhoea in Mexico [12,13], but nevertheless little is known of its prevalence in food.

We set out to determine whether chili sauces are potential vehicles of FBD and carried out an observational study to assess the prevalence of *E. coli* and ETEC in street-vended chili sauces. The area selected for the survey was 'La Villa', north of Mexico City, which has a high concentration of street-food vendors and consumers, with an average of 6000000 visitors estimated per year because of its importance as a national and international place of pilgrims. During summer–autumn 1999, 43 samples of street-vended chili sauces (30 green-chili, 13 red-chili) were collected. A record was made of the general hygienic conditions of the selling place and the street-vendor, the average amount of chili sauce added per taco and the number of tacos consumed per person, as well as the average number of consumers per stall/day. The acidity was determined for all samples (range of pH 4–5), and 100 μl of each sample and their respective dilutions were plated on MacConkey agar and incubated at 37 °C overnight. The number of *E. coli*-like colonies was counted and five colonies were selected and tested for indole production. Indole positive isolates were analysed by a colony hybridization method [14] using DNA probes to detect the genes for heat-labile (LT) and heat-stable (ST) enterotoxins. Probes were prepared by labelling the LT and ST PCR products with digoxigenin-11-UTP (Boehringer Mannheim GmbH, Mannheim, Germany) and the primers were as previously described [15]. The label was detected with anti-digoxigenin-AP antibodies (Boehringer Mannheim).

Table 1 shows that each of the five selected colonies of the ETEC positive green chili sauces was positive for LT and ST toxins, and thus was potentially pathogenic. Considering that consumers added 4–8 ml of chili sauce per taco, ingested 2–5 tacos per meal, that the stalls were visited on average by 50 consumers per day, and that one of the chili sauces contained $1{\cdot}3 \times 10^4$ ETEC/g, we estimated that consumption of a contaminated sauce could result in ETEC disease in at least 21000 consumers per year. This poses a significant health risk to consumers. Consumption of street-vended food and the risk of developing travellers' diarrhoea has been linked in Mexico [16–18], where, as in other countries, sampling of food and water from areas of endemic infection has demonstrated high rates of ETEC contamination [19–21] although the ETEC concentration in food was not reported. Experiments with well-fed volunteers show that to establish infection relatively high doses (10^8 cfu of ETEC) in water are required to achieve high attack rates [22]. However, it is widely held that when ingested with food the infectious dose may be reduced by at least 1000-fold.

Street-vended chili sauces in Mexico City are prepared, handled and sold under poor hygienic conditions. They are made at home the same day or a day before sale and remain exposed to the street environment for about 8 h without refrigeration providing conditions highly favourable for microbial growth. This survey shows that street-sold sauces are important potential vehicles of FBD as a result of (a) their wide daily consumption, (b) prevailing popular beliefs of their benefit, (c) inappropriate sanitary

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conditions and (d) the type and amount of microbial contamination detected. There is a lack of information on the prevalence of ETEC in foods worldwide due mainly to the fact that ETEC is not routinely screened for owing to the lack of a rapid and inexpensive detection method. To the best of our knowledge there is only one report of ETEC isolation from food in Mexico [19]. This latter study included food from homes, supermarkets, restaurants and street-vendors in Guadalajara, Mexico and from restaurants in Houston USA. ETEC was isolated only from two samples (shrimp and potato salad) purchased in a supermarket in Mexico.

Consumption of street-vended food in Mexico [16–18] and other developing countries [23–25] has also been linked to travellers' diarrhoea or 'Montezuma's revenge' in Mexico. Thus, attempts to improve the safety of this food should improve public health. Indeed, in order to reduce the risk posed by street-sold food, rather than penalizing their sale which impinges only upon the street-vendors economy, other measures are urgently required in big cities and tourist areas. For example, accessibility of street-food vendors to potable water with appropriate waste disposal and toilet facilities. Food safety educational campaigns for both handlers and consumers [26] and identification of the main pathogens and sources of food contamination would also be beneficial.

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