VARIABLE SURVIVAL OF *ESCHERICHIA COLI* O157 ISOLATES DUE TO DRYING ON CONCRETE

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Background

Escherichia coli O157 is carried asymptomatically in cattle and sheep gastrointestinal (GI) tracts (1, 2), but can cause disease in humans. Outbreaks of *E. coli* O157 disease have been linked to contaminated meat or meat products (3, 4, 5), and the pathogen has been found on meats at retail (6). Contamination of meat with *E. coli* O157 directly from GI tracts should be rare if hygienic techniques of slaughter and dressing are used. Instead, *E. coli* O157 persisting outside GI tracts on surfaces including food animals' coats (7, 8), lairage surfaces (9) and equipment surfaces (10, 11) may be more likely direct or indirect sources of meat contamination. However, the spread of *E. coli* O157 outside animal GI tracts on such surfaces may be influenced by the organisms ability to survive drying. The effects of drying on *E. coli* O157 in manure (12) or in fermented sausage or model systems (13, 14) have been studied. To our knowledge, there are no data on the response of *E. coli* O157 to drying on concrete, although the pathogen is frequently found on this common abattoir lairage surface (9). Also, previous studies have examined effects of drying on only one or a few *E. coli* O157 isolates (12, 13, 14). Therefore, the current study was conducted to measure the responses of multiple *E. coli* O157 isolates to drying on concrete, a surface commonly used in slaughterhouses and in meat processing plants.

Objective

To establish whether isolates from different sources (bovine coats, bovine and ovine faeces, retail meats and cases of human disease) have different survival rates when exposed to drying on concrete.

Methods

E. coli O157 isolates (123 in total) were from cases of human disease (31), meats (29), bovine and ovine faeces (32) and bovine coats (31). Isolates were subcultured twice in Luria Bertani broth at 37°C. Horse blood was chosen as the drying substrate because: a) its use eliminated a source of experimental variability, as blood is more homogeneous than other possible substrates including faecal material, and b) blood drops are common in slaughterhouses. Each isolate (20 µl of culture mixed with 1 ml of horse blood), was pipetted (20 µl spots) onto duplicate concrete blocks (10 mm x 10 mm x 5 mm high) prepared by a commercial concrete manufacturer. The CFU/spot was calculated after rehydrating in phosphate buffer pH7 for 20 min, vortexing for 10 sec, and plating onto columbia blood agar at the start and after 24.0 h drying at 19°C. Results were expressed as survival rate (CFU/spot after 24.0 h divided by CFU/spot at the start, multiplied by 100 = % survival). The survival rate of each isolate after drying on concrete was measured three times. For the purposes of this study, isolates with <10% survival rates are considered as sensitive to drying, and those with >50% survival rates as good survivors.

Results and discussion

A proportion of each *E. coli* O157 isolate population survived 24 h drying on concrete. The overall mean survival rate among the 123 *E. coli* O157 isolates studied was 22.9%, but there was a wide range of responses to drying (Table 1). More than 50% of the initial inocula were recovered from the concrete after drying for those isolates that survived best (Figure 1). In contrast, less than 10% of the initial inocula were recovered in the case of the most sensitive isolates in the study. These results, showing different sensitivities among the *E. coli* O157 isolates to drying on concrete, indicate that exposure to similar drying in the abattoir lairage and/or slaughterhouse environments could selectively determine which isolates will pass further along the meat chain. The *E. coli* O157 isolates originated from four different sources (cases of human disease, meats, bovine and ovine faeces, and bovine coats). There was no difference between the average responses of the three groups of isolates that originated from meats, bovine or ovine faeces or bovine coats (mean survival rates of 27.7, 26.0 and 22.9 %, respectively; Table 1). However, the group of isolates that originated from cases of human disease were, on average, significantly more sensitive to drying (mean survival rate of 15.3%) than isolates from the other three sources ($P < 0.05$) (Table 1). A greater percentage (2- to 6-fold greater) of *E. coli* O157 isolates originating from cases of human disease were sensitive to drying (<10 % of the initial inocula survived) than isolates originating from the other three groups (Figure 1). Also, none of the *E. coli* O157 isolates that originated from cases of human disease were classified as good survivors (more than 50% of the initial inocula survived), but some isolates from each the other three sources were good survivors (Figure 1). Our observation that *E. coli* O157 which originated from cases of human disease were, as a group, significantly ($P < 0.05$) more sensitive to drying, is difficult to explain. We could speculate that human isolates used in the current study were more adapted to the warm, moist human GI tract, and therefore, were less able to survive in the colder, dryer environment outside than the other isolates previously adjusted to lower temperatures. However, further studies are necessary to confirm this, particularly as the isolates from animal faeces behaved differently.

Concluding remarks

The ability of individual *E. coli* O157 isolates to survive drying outside animal or human GI tracts could be one of factors determining, through a process of "natural selection", their transfer along the food-meat chain. Further studies are necessary to determine the possible cause(s) of *E. coli* O157 isolates variable ability to survive drying, and to investigate the public health implications of that phenomenon.

Pertinent literature

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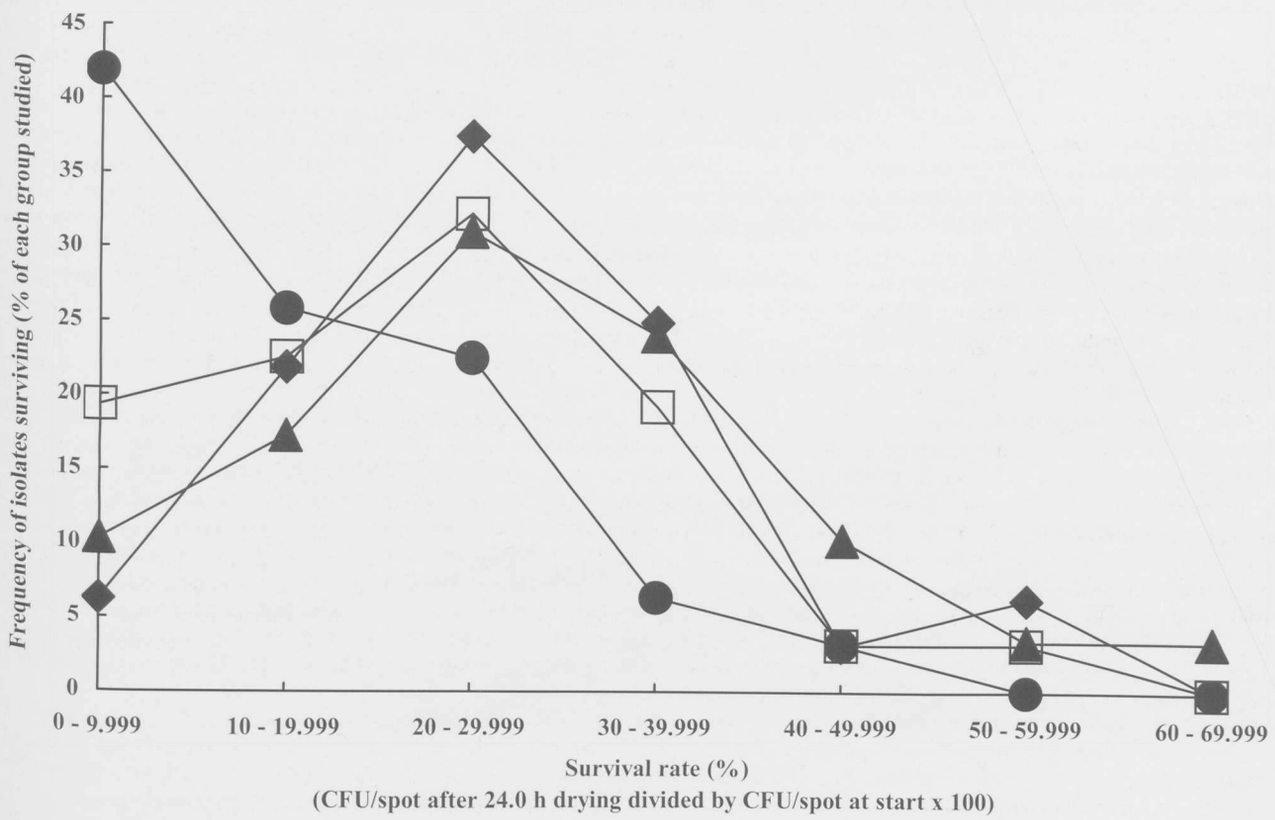
Table 1. Average survival rates of 123 *E. coli* O157 isolates from four different origins during drying on concrete.

Proportion of surviving population	Cases of human disease ($n = 31$)*	Meat ($n = 29$)*	Bovine and ovine faeces ($n = 32$)*	Bovine coats ($n = 31$)*
Minimum	1.3%	1.2%	5.2%	2.0%
Maximum	48.0%	61.9%	53.8%	58.6%
Mean ± SE	15.3 ± 2.1%	27.7 ± 2.6%	26.0 ± 2.1%	22.9 ± 2.3%

SE = standard error; * each isolate tested in triplicate

Figure 1. Frequency distribution of survival rates for *E. coli* O157 isolates from four different origins.



●, human; ▲, meat; ◆, bovine and ovine faeces; □, bovine coat