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Survival of Acid Resistant Shiga Toxin-Producing *Escherichia coli* to Organic and Inorganic Acids

K. M. Villatoro[1]*, L. Yang[1], and X. Yang[1]

[1]Animal Science, University of California Davis, Davis, CA, USA
*Corresponding author. Email: kmvillatoro@ucdavis.edu (K. M. Villatoro)

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Objectives

The shiga toxin-producing *Escherichia coli* (STEC) has been involved in a series of outbreaks around the world. Organic acids, such as lactic acid, have been used in meat plants to control STEC. However, STEC has shown its capacity to survive in low acid environments, which may compromise the effectiveness of organic acid interventions. Similarly, STEC may also survive in human stomach fluid (pH 1.5– 3.5), which can potentially result in clinical infections. Thus, the objective was to compare the ability of acid-resistant (AR) STEC to survive in inorganic and organic acid at different pH levels.

Materials and Methods

For this study, five AR STEC strains were used to make an inoculum for the study. The AR STEC inoculum was challenged in acidified TSB with lactic acid (2% at pH 3.2; 5% at pH 2.8) and TSB with hydrochloric acid (HCl; to simulate human stomach acid) at pH 1.6, 2.8, 3.2 and 3.5 for 2, 4, 6, and 8 h at 37°C. After the acid challenge, the survival bacteria counts were plated on TSA plates and incubated for 48 h at 37°C. The complete experiment was repeated five times. The data was analyzed using the generalized linear model of the SAS 9.4.

Results

The AR STEC showed a distinct ability to survive in organic and inorganic acid, even with the same pH. Exposure of AR STEC to HCl with pH 3.2 and 3.5 for 8 h resulted in the highest ($P < 0.01$) survival counts across all the treatments. When AR STEC was challenged with HCl at pH 1.6, no survival cells were recovered on TSA plates after 4 h. No additional reduction of AR STEC was observed when exposure time to HCl at pH 2.8 and 3.2 was increased. However, no growth ($P < 0.01$) of AR STEC was observed after exposure to lactic acid at the same pH by time.

Conclusion

Lactic acid (2% and 5%) effectively controlled the growth of AR STEC in pure culture. However, if AR STEC can survive through the meat production chain, they may survive in the human stomach for an extended period when the pH is higher than 1.6. The results of the study emphasize that it is necessary to eliminate AR STEC before they enter the human body, as they are more resistant in inorganic acid, such as the HCl found in human stomach fluid.

Table 8. Least squares means (LSmeans; standard error) of the survival counts for acid-resistant *Escherichia coli* exposed to hydrochloric acid (HCl) and lactic acid (LA) at different pH through time. [a-g] Least squares means with a different superscript letter are significantly different ($P < 0.05$).

	Treatments					
Time	HCl pH: 1.6	HCl pH: 2.8	HCl pH: 3.2	HCl pH: 3.5	LA 2% (pH: 3.2)	LA 5% (pH 2.8)
0h	8.8 (0.1)^{a}	8.8 (0.1)^{a}	8.8 (0.1)^{a}	8.8 (0.1)^{a}	8.8 (0.1)^{a}	8.8 (0.1)^{a}
2h	4.8 (0.1)^{e}	6.3 (0.1)^{bc}	6.5 (0.1)^{b}	6.5 (0.1)^{b}	0 (0.1)^{g}	0 (0.1)^{g}
4h	2.9 (0.1)^{f}	6.0 (0.1)^{bcd}	6.5 (0.1)^{b}	6.3 (0.1)^{bc}	0 (0.1)^{g}	0 (0.1)^{g}
6h	0 (0.1)^{g}	5.9 (0.1)^{cd}	6.4 (0.1)^{bc}	6.3 (0.1)^{bc}	0 (0.1)^{g}	0 (0.1)^{g}
8h	0 (0.1)^{g}	5.5 (0.1)^{d}	6.3 (0.1)^{bc}	6.3 (0.1)^{bc}	0 (0.1)^{g}	0 (0.1)^{g}