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Heat Resistance in *Escherichia coli* and its Implications on Ground Beef Cooking Recommendations in Canada

X. Yang[1]*, F. Tran[1], and M. Klasse [2]

[1]Lacombe Research and Development Centre, Agriculture and Agri-Food Canada, Lacombe, Canada
[2]Technical Services, Canadian Cattlemen's Association, Calgary, Canada
*Corresponding author. Email: xianqin.yang@canada.ca (X. Yang)

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Objectives

Recent reports of an extremely heat resistant but non-pathogenic beef *Escherichia coli* strain, AW 1.7, raised concerns over the adequacy of cooking ground beef to 71°C in Canada. The objective of this study was to assess the adequacy of the current cooking recommendations for ground beef in relation to heat resistant *E. coli*.

Materials and Methods

In total, 8 potentially heat resistant *E. coli* strains (4 generic and 4 *E. coli* O157:H7) from beef along with *E. coli* AW1.7 were included in this study. Heat resistance of the strains was first evaluated by decimal reductions at 60°C ($D_{60°C}$-value), the time required to have a log reduction of the bacterial population at 60°C. The more heat resistant strains of each group (*E. coli* 62 and 68, and *E. coli* O157 J3 and C37) were further assessed for their heat resistance when grown in Lennox Broth without salt (LB-NS), LB + 2% NaCl and Meat Juice (MJ). Then, the two most heat resistant *E. coli* O157 strains (J3 and C37) and *E. coli* AW 1.7 were each introduced to extra lean ground beef (100 g) in vacuum pouches for determination of their *D*-values at three temperatures, 54, 57, and 60°C, from which a *z*-value for each strain was derived. The thermal characteristics of all three strains were fed into a predictive model to determine the process lethality of cooking burgers to 71°C with resting for up to 5 min. Finally, inactivation of the most heat resistant *E. coli* strain AW1.7, assessed in this study and reported in the literature, in ground beef was validated by grilling burgers containing 6.20 ± 0.24 log CFU/g of the organism to 71°C without or with a resting of 3 or 5 min.

Results

The $D_{60°C\text{-values}}$ for these strains varied from 1.3 to 9.0 min, with J3 and AW1.7 being the least and most heat resistant strains, respectively. The $D_{60°C\text{-values}}$ for *E. coli* 62 and 68 were similar and were not affected by growth medium, while the heat resistance of C37, J3 and AW1.7 varied with the growth medium. When heated in extra lean ground beef (100 g) in vacuum pouches, the mean $D_{54°C}$, $D_{57°C}$, and $D_{60°C\text{-values}}$ were 44.8, 18.6 and 2.9 min for C37, 13.8, 6.9 and 0.9 min for J3, and 40.5, 9.1 6.1 min for AW1.7. The derived *z*- and D71°C-values were, respectively, 5.0, 5.1 and 7.3°C; and 0.022, 0.008, and 0.156 min. Burger temperatures continued to rise after being removed from heat when the target temperature was reached, by up to 5°C, and resting of 1 min would result in a destruction of 133, 374, and 14 log C37, J3 and AW1.7, estimated from process lethality. When burgers inoculated with AW1.7 were cooked to 71°C, 14 of the 15 burgers yielded no *E. coli*, while the 15th had a reduction of 4.5 log. Additional resting of 3 or 5 min resulted in complete elimination of AW 1.7.

Conclusion

It has been predicted that 2% of *E. coli* from beef may carry heat resistant genes. The findings in this study, along with the very low level of total *E. coli* expected in ground beef in Canada, suggest that cooking ground beef to 71°C should be adequate to ensure the safety of such products.