

E. coli O157

Research and Education Strategy Fact Sheet



Implications of Heat Resistant E. coli for Ground Beef Cooking Recommendations

Heat Resistant *E. coli* and Ground Beef

In recent years, increasing attention has been devoted to the potential food safety implications of heat resistant bacteria. A significant number of media stories have raised the question as to whether the current recommendation, to cook ground beef until it reaches a temperature of 71°C, is adequate. To address this issue the Canadian Cattlemen's Association (CCA) instigated research to be undertaken by Dr. Xianqin Yang at the AAFC Lacombe Research and Development Centre. Recognizing the importance of the question, CCA also created an advisory panel of five additional scientists to review the experimental methods prior to the start of the research.

Research Methods and Study Design

Heat resistance in *E. coli* is thought to be related to the presence of a specific DNA segment in bacteria called the "locus of heat resistance". Heat resistance of bacteria is also influenced by the environment they

are exposed to before and during heat treatment. Heat resistance is measured by the amount of time



at a given temperature required to kill 90% of the bacteria. This value is known as the *decimal reduction* or D-value.

E. coli, in general, is not heat resistant. At 71°C, the temperature ground beef is required to achieve, the killing of *E. coli* is expected to be essentially instantaneous. The key focus of the experiment was to first measure the heat resistance of a number of different *E. coli* strains. Ground beef was then artificially contaminated in the laboratory by placing approximately 100 million of the more heat resistant *E. coli* bacteria into each beef patty. It is important to note that such high levels of heat resistant *E. coli* are extremely unlikely to occur naturally but are used in experimental situations. The patties were then cooked to 71°C and then examined to determine

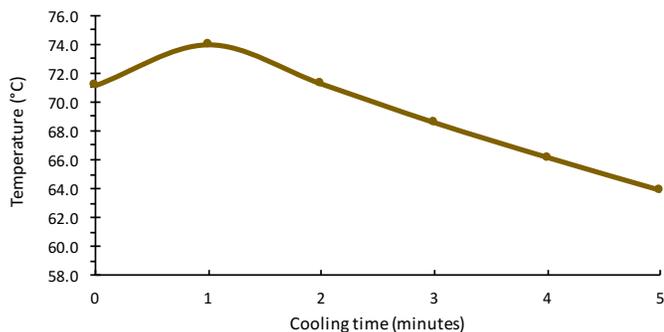
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if sufficient levels of *E. coli* could be inactivated. Hamburgers, like any other food, are not consumed right off the grill, i.e. as soon as the target cooking temperature is reached. Therefore the temperatures of hamburgers cooked to 71°C were monitored while they cooled for up to five minutes at room temperature. This allowed the research to determine if there was enough heat to destroy additional *E. coli* even after the product was removed from the grill for different time periods.

Results and Discussion

Nine *E. coli* strains were tested for heat resistance. Three strains, including the most heat resistant pathogenic and nonpathogenic *E. coli*, were tested in ground beef. Their D-values were found to range from 0.5 seconds to 10 seconds. The most heat resistant strain was added to beef patties that were then cooked to an internal temperature of 71°C using a clamshell grill. Within one minute after cooking, the internal temperature of the patties continued to increase, in some instances as high as 75°C. The average temperatures dropped back to 71°C after cooling for approximately 2 minutes.



Internal temperatures at patty centers after cooking to 71°C and cooling at room temperature for up to five minutes.

A small amount of heat resistant *E. coli* was found in 1 of 15 burgers placed in ice immediately after removing from the grill. No surviving *E. coli* was found in burgers cooked to 71°C and cooled for 3 or 5 min. It was calculated that the small amount of *E. coli* found in the one patty would be destroyed by an additional 13 seconds at 71°C. On average the product remained at 71°C or higher for 2 minutes after removing from the grill, easily meeting this requirement. Accordingly, product safety could be assured even when artificially high levels of heat resistant bacteria were placed into the patty.

Three additional findings provide support for the safety of ground beef relative to heat resistant *E. coli*. Firstly, research has shown that only about 2% of *E. coli* strains from beef are estimated to be heat resistant (1). Secondly, heat resistance and the ability to cause illness are traits not likely to be present at the same time in a *E. coli* bacteria (2). Lastly, beef produced in Canada carry very low levels of any type of *E. coli* (3). The likelihood of having heat resistant and pathogenic *E. coli* in high numbers in Canadian ground beef is then extremely unlikely.

Conclusion

The current recommendation, of both Health Canada and the USDA, to cook ground beef until it achieves a temperature of 71°C continues to be valid.

References

1. *Food Microbiology* 64:96-103
2. *FEMS Microbial Ecol*, 2017, doi: 10.1093/femsec/fix098.
3. *J. Food Prot.* 79:1325-1331 & *J. Food Prot.* 75:144-149