Growth of Generic *E. coli* and Aerobic Bacteria on Beef Muscle held at 50°F for 8 Hours[1]

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Introduction

Bacteria are everywhere in our environment. Relative to food safety and quality, the two primary kinds of bacteria which are of consequence are pathogenic bacteria and spoilage bacteria. Spoilage bacteria are generally not harmful, but they will cause food to deteriorate or lose quality by developing a bad odor or texture. Pathogenic bacteria are those such as *Salmonella*, *E. coli* O157:H7, *Campylobacter jejuni*, *Listeria monocytogenes*, and *Staphylococcus aureus*, all which cause food-borne illness and cannot be seen or smelled (International Commission on Microbiological Specification for Foods, 1996).

The safety of meat products is the most important parameter to consumers and the food industry alike. The two primary pathogens of concern with fresh beef are *Salmonella* and *E. coli* O157:H7. Multiple steps are taken to reduce the presence of pathogens on beef cattle at the farm (Loneragan and Brashears, 2005) at the processing plant (Koohmaraie et al., 2005; Beef Industry Food Safety Council, 2003a) and during further processing (Beef Industry Food Safety Council, 2003b; 2006). Heating beef products to 162°F for 16 seconds or to 135 °F for 45 seconds will eliminate *Salmonella* and *E. coli* O157:H7 (Venkitanarayanan and Doyle, 2007). Irradiation is an effective method of eliminating pathogens; however, U.S. consumers are fearful of irradiated products (Venkitanarayanan and Doyle, 2007). Therefore, there is always an element of risk for processors of raw, ground beef products, because of the lack of a cooking step.

USDA inspected meat processing facilities try to minimize microbial growth and microbiological risk by refrigerated temperature control. However, refrigeration costs increase when processing at lower ambient temperatures. Therefore, some processors fabricate fresh meat at ambient temperature as high as 50°F. Little documentation exists of how long fresh meat can be held at this temperature without experiencing growth of pathogenic bacteria, particularly *E. coli* O157:H7 and *Salmonella*.

The purpose of this study was to determine the growth of generic *E. coli* and aerobic bacteria as indicators of pathogenic bacteria on beef muscle held at 50°F for eight hours.

Experimental Procedure

No live pathogenic bacteria were used in this study as all processes were conducted in a USDA inspected processing facility. A vacuum packaged beef inside round roast was obtained at retail, brought to the UF Meat Laboratory and held at 34°F until the roast was cut into 25g cubes using a flame sterilized knife. After cutting, the cubes (n = 7) were placed on a tray and held at 50°F for 0, 2, 4, 5, 6, 7 or 8 hours until each sample was placed in a Stomacher bag

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with 225 ml of peptone water. The beef cube was massaged within the bag for one minute to incorporate the solution into the cube, then 1 ml of the liquid was transferred to a test tube containing 9 ml of peptone water. The tube was vortexed, and the procedure from the initial test tube repeated on the subsequent tubes four times, resulting in five tubes containing dilutions ranging from 10^{-1} to 10^{-5}.

After diluting, 1 mL of each dilution from the seven samples was placed on an aerobic petrifilm plate to assess aerobic plate count (APC) and an *E. coli* petrifilm plate. Three samples of each plate were generated and all plates were placed in a 95°F incubator for 48 hours, prior to counting. Generally, APC measures bacteria that grow in the presence of oxygen, serving as an indicator of the presence of spoilage organisms, and generic *E. coli* are indicators of the presence of fecal bacteria contamination. Results were reported as a logarithmic function of the colony forming units (CFU) per g and analyzed using the repeated measures function of SAS (SAS Inst., Inc., Cary, NC), considering time of measurement as a fixed effect and triplicate replication as a random effect.

Results and Discussion

No *E. coli* was isolated from the initial product (Table 2). Accordingly, there was no difference in *E. coli* growth rate for beef held at 50°F up to 8 hours. For APC, 15.1 CFU were identified from the initial product (Table 2). However, the APC of beef products stored at 50°F did not increase ($P > 0.10$) for any length of storage up to 8 hours.

This work complements the findings of other authors. Ingham et al. (2007) incorporated live pathogenic *E.coli* and Salmonella with various fresh meat products prior to aerobic storage at 50°F. At that ambient temperature, pathogens were dormant or in the lag phase of growth for 22 hours (Table 3). In another study, Ingham et al. (2005) reported one lb ground beef packages thawed 9 hours at 72 or 86°F resulted in 0.2 and 0.5 logarithmic increases of pathogens on the product surface, respectively.

Conclusion

Most processors use 41°F as a critical control point for holding beef to prevent an increase in hazardous pathogen growth. This data and other supporting documentation sited in this report suggest the critical limit can be increased to 50°F without jeopardizing the consumer's health.

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Table 1. Minimum, optimum, and maximum ambient temperature for pathogenic growth.

	Ambient temperature (°F)		
Organism	**Minimum**	**Optimum**	**Maximum**
Campylobacter jejuni	90	108-113	113
Staphylococcus aureus	45	95-104	118
E. coli O157:H7	45	95-104	115
Salmonella	41	95-99	117

Table 2. Growth of generic *E. coli* and aerobic bacteria as indicators of pathogenic bacteria on beef muscle held at 50°F for eight hours.

Hour	**Colony Count for E. coli (CFU/g)**	**Colony count for aerobic bacteria (CFU/g)**	**Log Difference from Hour 0.**	***P*-value**
0	0	15.1		
2	0	16.2	+0.011	$P > 0.10$
4	0	21.3	+ 0.062	$P > 0.10$
5	0	14.5	-0.006	$P > 0.10$
6	0	18.0	+0.029	$P > 0.10$
7	0	17.9	+0.028	$P > 0.10$
8	0	16.4	+0.013	$P > 0.10$

Table 3. Lag Phase Duration (LPD) and Growth Rate (GR) for Various Meat Sources Stored at 50°F.

	***E. coli* 0157:H7**		***Salmonella***	
Product	LPD (hrs)	GR (log CFU/min)	LPD (hrs)	GR (log CFU/min)
Ground Pork	38.1	.0004	54.7	.00048
Ground Beef	27.1	.0004	46.4	.0002
Poultry			22.7	.0004