

# Presence of pathogenic bacteria in ground beef during consumer thawing and food-handling habits.

Lea A. Kinman<sup>1\*</sup>, Maria Barbara Mora Garcia<sup>1</sup>, Janice Speshock<sup>2</sup>, Randy M. Harp<sup>3</sup>

<sup>1</sup>Department of Animal Science and Veterinary Technology, Tarleton State University, Stephenville, TX 76402, USA

<sup>2</sup>Department of Biological Sciences, Tarleton State University, Stephenville, TX 76402, USA

<sup>3</sup>School of Agriculture, Texas A&M University-Commerce, Commerce, TX 75428, USA

## Abstract

This study evaluated the presence of foodborne pathogens during thawing procedures and handling methods. Store bought ground beef chubs were individually packaged (150 g), and frozen at -25°C. 1 g samples were collected prior to handling to evaluate bacterial presence from three thawing methods; refrigeration (RF), cold water (CW), and room temperature (RT). Patties were then made by bare hand following designated hand cleaning methods: Centers for Disease Control and Prevention method (CDC), Purell® liquid sanitizer method (SANT), and not washing hands (NW). 1 g samples were collected to evaluate bacterial presence after making patties. The interaction between thawing method and hand cleaning method indicated that *Escherichia coli* and *Shigella* spp. presence was significantly higher when using RT thawing method and NW hand cleaning method. *Campylobacter jejuni* remained higher using RT and RF thawing with SANT hand cleaning method.

**Keywords:** Ground beef, Pathogens, Thawing method, Food handling, Bacteria.

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## Introduction

Foodborne diseases are a public concern worldwide. In 2015 the Center for Disease Control and Prevention estimated that 48 million people become sick from a foodborne illness [1]. The Foodborne Diseases Active Surveillance Network [2] indicated that the majority of these cases have been caused by *Campylobacter jejuni*, *Listeria monocytogenes*, *Salmonella* spp., Shiga-toxin *Escherichia coli* (STEC) O157, *Shigella*, *Vibrio* and *Yersinia*. According to Food-Net, meat and poultry cause 22% of the outbreaks, and 31 reported cases during 2009-2010 were linked to beef [2]. Furthermore, the CDC stated that STEC, *Clostridium perfringens*, *Salmonella* spp., and *Campylobacter jejuni* were the main causative pathogens in the outbreaks from beef [1].

According to Anderson et al., Byrd-Bredbenner et al. Redmond and Griffith consumers indicated they became ill from a foodborne illness at least once after eating in a restaurant, school, or church [3-5]. However, home is the primary place where outbreaks can occur, but consumers do not consider private homes as a risky place to find pathogen contamination [4].

The purpose of this study was to determine the presence of foodborne pathogens in ground beef after thawing, handling and cooking. The rationale is to mimic common consumer food-handling practices at home. This could increase knowledge about food safety at home and also improve consumer awareness about safer food-handling methods to avoid illness. Therefore, the objectives of this study were:

- To determine the presence of foodborne pathogens in ground beef using different thawing methods.

- Determine adequate hand cleaning methods during pre-cooking in ground beef patties.
- Determine the survival of foodborne pathogens following cooking.

## Materials and Methods

### Ground beef preparation

Fresh ground beef (fat content of 20%) chubs were purchased from a local retail store. Ground beef (13,607 g) was mixed by hand with sterile gloves to guarantee even distribution. From the batch, 150 g portions were individually packaged in labelled sterile Nasco Whirl-Pak bags® and frozen at -25°C.

### Defrosting of ground beef

Ground beef packages were defrosted according to predetermined treatment; refrigeration (RF), cold water (CW) and room temperature (RT). Each thawing treatment contained 15 samples with a corresponding hand cleaning method; Centers for Disease Control and Prevention (CDC), Purell® hand sanitizer (70% alcohol v/v) (SANT), and not washing hands (NW).

Packages of ground beef labelled for refrigeration (RF) thawing method were kept in a refrigerator (Trautsen® model G10010) at 4°C for 18 h. One g samples of ground beef were collected from each bag to identify presence of pathogens.

For the cold water (CW) thawing method, ground beef packages were submerged in a kitchen sink that contained cold

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water (25°C) for 40 min. 1 g samples were collected from each bag to identify pathogen presence.

For room temperature (RT) thawing method, ground beef packages were placed on a kitchen counter at room temperature (20-22°C) for 8 h. One g samples were collected for pathogen determination.

### Ground beef patty formation and cooking

Each patty was made by hand following designated hand preparation method. Centers for Disease Control and Prevention method (CDC) involved wetting hands with cold running water, rubbing hands and between fingers with soap, scrub for at least 20 sec, rinse well under clean running water, and drying with a clean paper towel. Liquid sanitizer (SANT) method consisted of 2 pumps from a Purell® bottle and rubbing hands together to distribute product evenly. For the CDC and SANT method the hands were cleaned before the first patty was made only. This was to simulate a typical consumer hand cleaning technique in the home. The third hand preparation method entailed not washing hands (NW). One g samples were collected from each patty for determination of pathogens. All patties were cooked to an internal temperature of 71.1°C to determine pathogen survival.

### Microbiological analysis

Ground beef samples were microbiologically analysed on the same day of collection. One g samples were deposited in 15 mL centrifuge tubes that contained 10 mL saline solution. Tubes were then sonicated for 2 min to facilitate agitation. Samples were agitated in a standard mini vortex. Following agitation 0.10 mL of the sample was placed on each agar plate: Eosin Methylene Blue (EMB) agar was used to identify *E. coli*, DIFCO TM *Salmonella*, *Shigella* (SS) agar was used to identify *Shigella*, BBL Mannitol Salt Agar (MSA) was used to identify *Staphylococcus spp.*, and Campy Cefex Agar was used to identify *Campylobacter spp.* Plates were incubated at 30°C for 24 h to allow growth of pathogens if present. Colonies were counted and documented following the 24 h incubation period and reported as Colony Forming Units (CFU) per 1% solution.

**Table 1.** Interaction of thawing methods† and handling preparation methods†† for significant pathogens (CFU/1% solution) in ground beef patties.

Pathogen	RF			CW			RT			SEM
	CDC	SANT	NW	CDC	SANT	NW	CDC	SANT	NW	
<i>Shigella spp.</i>	0.46b	2.86b	0.13b	0.00b	0.00b	0.00b	7.13b	0.00b	27.93a	5.08
<i>Escherichia coli</i>	0.00c	0.26bc	3.06bc	0.00c	0.06c	0.13c	5.33b	1.20bc	15.93a	1.85
<i>Campylobacter jejuni</i>	0.00c	51.06a	0.13c	0.06c	2.40c	0.26c	0.00c	54.00ab	28.73b	8.2

a,b,c Different superscript within a row indicate significant differences (p<0.05)

†RF: Refrigeration, CW: Cold water, RT: Room temperature.

††CDC: Center for Disease Control and Prevention method, SANT: Sanitizer, NW: Not washing hands.

### Statistical analysis

The experiment was analysed as a 3 × 3 factorial design with five replications. The statistical analysis of the mean population of pathogens and interaction between thawing method and handling preparation were conducted using Statistix 10 (Statistix, ver.10.0, USA) statistical software. Least square differences (LSD) were separated when differences were detected at the P<0.05 level.

### Results and Discussion

Table 1 indicated an interaction between thawing methods and hand preparations methods. *Shigella spp* and *E. coli* presence were higher (p<0.05) when using RT thawing method and NW hand preparation method. According to Sage and Ingham, the presence of *E. coli* O157:H7 during freezing storage and thawing vary due to the kind of strain [6]. *E. coli* O157:H7 did not affect food safety of ground beef when it was thawed at 23°C during 3 h, however, thawing for longer periods could lead to a faster bacterial growth [6,7]. Ground beef in the current study was thawed at RT for 8 h at 22°C. Moreover, according to Ingham et al. thawing ground beef greater than 453 g for more than 9 h is also a factor that will increase *E. coli* counts [7].

Table 1 also indicated a significant presence (p<0.05) of *C. jejuni* during RF and RT thawing when SANT hand preparation was used. Bostar et al., stated that under normal refrigeration temperatures *C. jejuni* will not normally grow, however, Trokhymchuk et al., found that retail storage for ground beef can be appropriate for *C. jejuni* survival [8,9]. According to the Hand Hygiene in Health Care Guide, alcohol-based hand sanitizer is the most preferable way to clean hands when they are not visible dirty because of its effectiveness to reduce bacterial counts on hands [1]. A study by Edmonds et al. tested the Sani Twice method and two other sanitizers that contained 62% and 70% alcohol [10].

The Sani Twice method for hand disinfection was similar or equivalent to hand washing with water and soap. The use of

alcohol-based sanitizer with 62% alcohol was similar if using hand washing without soap. The sanitizer with 70% alcohol

was the most effective method to decrease microorganisms on hands. According to Bloomfield et al. hand sanitizer and hand washing should be done in combination when handling meat and poultry [11]. Todd et al., found that alcohol gels significantly reduced bacterial load on hands compared with regular soap or antibacterial soap; nevertheless, sanitizer's decreased effectiveness when hands are in contact with ground beef, chicken juices, faecal material and organic soils [12]. Although hand sanitizer seem to be a good source as a barrier for microorganism transmission from hands to foods, the CDC has indicated that a misapplication of the product could alter its effectiveness. Fingertips, between fingers and thumbs are the most often missed places when applying hand sanitizer [1]. No differences were found in *Staphylococcus* spp. among thawing method and hand preparation method.

## Conclusion

The present study was designed to mimic common household consumer food handling practices (thawing and hand cleaning preparation) to identify the possible presence of foodborne pathogens in ground beef. Handwashing is a sanitary process to eliminate transient and environmental flora on human hands, therefore, improper or lack of handwashing contribute to an increment of pathogen presence in foods and a risk of possible foodborne diseases [10,12]. Even though a proper handwashing protocol should be followed, natural skin flora will still be present on hands, and cross-contamination with utensils and surfaces may occur. Previous studies that have evaluated the effectiveness of sanitizer products have concluded that it is a good tool for log reduction when hands are not visible dirty, however, it is known that *C. jejuni* is a hard pathogen to wash from human hands. Based on data from this study it is advised to follow the CDC method for hand washing and allow ground beef to thaw at refrigeration temperatures to ensure minimal occurrence of potential pathogens [13]. It should be noted that patties from all treatments were cooked to an internal temperature of 71.1°C to determine pathogen survival, and all pathogens were killed during cooking.

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### \*Correspondence to:

Lea A. Kinman  
 Department of Animal Science and Veterinary Technology,  
 Tarleton State University, Stephenville  
 TX 76402, USA  
 E-mail: kinman@tarleton.edu