Survival of *Salmonella* and *Escherichia coli* O157:H7 during freezing, thawing and cooking of ground beef patties, simulating common household practices

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INTRODUCTION

Ground beef patties constitute conventional Ready-To-Cook meat products, ranked among the top most frequently consumed meat products worldwide. These products may be prepared in-house from ground beef or may also be found available in the form of pre-shaped frozen patties, which is highly convenient for Quick Service Restaurants. In the recent years, ground beef has been linked with several outbreaks of foodborne diseases caused by *Salmonella* or *Escherichia coli* O157:H7. Therefore, Food Safety authorities have issued general guidelines for the proper handling of ground beef in households or catering services. Through these guidelines it is recommended that ground beef should be stored in refrigerators for 1-2 days or in freezer up to 4 months, thawed in refrigerator or in microwave and cooked until the internal temperature of patties reaches 71°C. However, the storage and cooking practices being applied by the consumers, either in households or in catering services and restaurants, are generally based on personal preferences and convenience for handling and consuming foods, rather than on the existing recommendations. Any deviation from the suggested guidelines may likely compromise the safety of ground beef and increase the risk of foodborne diseases. According to the above, we aimed to evaluate the effect of frozen storage, thawing and cooking method of beef patties on the survival of *Salmonella* and *E. coli* O157:H7, simulating common consumer-style practices.

MATERIALS & METHODS

Portions (400 g) of ground beef were inoculated (~6.5 log CFU/g) with a five-strain composite of *Salmonella* or a three-strain composite of *Escherichia coli* O157:H7 and stored at -22°C. After 5 and 75 days of frozen storage, thawing took place as follows: (i) in refrigerator at 4°C for 16 hours; (ii) at 20°C for 12 hours, simulating thawing on counter, or; (iii) in microwave for 22-24 minutes. Following thawing, 90 g beef patties were shaped and cooked by broiling or in pan-grill up to two levels of internal temperature: 60°C, simulating undercooking or 71°C (recommended cooking temperature). In addition, the survival of the two pathogens after direct cooking of frozen patties was studied, simulating commercial cooking practices in catering services and restaurants. The temperature of the samples during thawing or cooking was measured with type-K thermocouples, which were fitted in the geometrical center of the patties. Changes in the microbial populations that survived after cooking of patties were monitored on TSA (total viable counts), CT-SMAC (*E. coli* O157:H7) or XLD (*Salmonella*).
RESULTS & DISCUSSION

The populations of the pathogens exhibited slight reduction (0.5 – 0.7 log CFU/g) during frozen storage for 5 or 75 days. This may occurred due to the mechanical injury of the cells during freezing. The time-temperature profile during thawing of ground beef overnight (12 hours) at 20°C showed that the samples maintained in the “danger zone” (5-60°C) for over 7 hours. This extended exposure to ambient conditions resulted in an increase of 1 log CFU/g of both pathogens. Cooking by broiling was more effective for eliminating 6.5 logs of both microorganisms compared to cooking in pan-grill, especially when the target internal temperature was 71°C. This may have occurred due to the slower heat transfer rate and the longer exposure of the patties to heat during cooking in broiler compared to pan-grill (Figure 1). Undercooking (60°C) resulted only in 0.6 – 2.8 log CFU/g and 0.6 – 1.8 log CFU/g decrease of Salmonella and E. coli O157:H7 populations, respectively, regardless of the cooking method. Defrosting methods did not affect significantly (p<0.05) the survival of the pathogens during subsequent thermal treatments. In contrast, frozen storage for 75 days enhanced the survival of E. coli O157:H7, as the populations of the pathogen remained at high levels, even when cooked by broiling at 71°C (1.7 – 3.1 log CFU/g).

![Image](image_url)

**Figure 1** Changes of temperature in the geometrical center of beef patties during cooking in broiler (▲ - 60°C; ★ - 71°C) or pan-grill (● - 60°C; ♦ - 71°C), after thawing in refrigerator (4°C / 16 h; a), kitchen counter (20°C / 12 h; b), microwave (c) or without thawing (d)

CONCLUSION

The results may be used in the development and/or the revision of guidelines for the appropriate practices, associated with defrosting and cooking of patties in households or catering services.