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Abstract

In 2003, the New Mexico Department of Health linked an outbreak of Salmonellosis with consumption of beef jerky. Due to the increasing commonality of foodborne illness associated with dried meats, in 2004 USDA/FSIS published the Compliance Guideline for Meat and Poultry Jerky Produced by Small and Very Small Plants, which addresses the issues of how to obtain adequate lethality and verify adequate drying. Small meat businesses that produce jerky products must validate that their processes achieve a 5-log reduction of E. coli O157:H7 and a > 6.5-log reduction of Salmonella. The objective of this study was to determine the effects of thermal processing temperatures and times on reducing E. coli O157:H7 and Salmonella in chopped and formed beef jerky.

Keywords

Cattlemen's Day, 2007; Kansas Agricultural Experiment Station contribution; no. 07-179-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 978; Beef; Cattle; Lethality; Jerky

THERMAL PROCESS FOR JERKY PROVIDES PROPER LETHALITY FOR CONTROLLING PATHOGENS

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Introduction

In 2003, the New Mexico Department of Health linked an outbreak of Salmonellosis with consumption of beef jerky. Due to the increasing commonality of foodborne illness associated with dried meats, in 2004 USDA/FSIS published the Compliance Guideline for Meat and Poultry Jerky Produced by Small and Very Small Plants, which addresses the issues of how to obtain adequate lethality and verify adequate drying. Small meat businesses that produce jerky products must validate that their processes achieve a 5-log reduction of *E. coli* O157:H7 and a $\geq$ 6.5-log reduction of *Salmonella*. The objective of this study was to determine the effects of thermal processing temperatures and times on reducing *E. coli* O157:H7 and *Salmonella* in chopped and formed beef jerky.

Experimental Procedures

Meat Batter Preparation and Inoculation. Fresh chopped and formed all-beef jerky batter was obtained from a commercial processor. The product was separated into three 4-lb batches. Two treatments, consisting of an *E. coli* O157:H7-inoculated batch and a *Salmonella*-inoculated batch, were prepared by adding an *E. coli* O157:H7 five-strain inoculum or *Salmonella* five-strain inoculum and thoroughly mixing into the jerky batter. A control batch was prepared by adding sterile deionized water into the meat batter.

Batter was extruded using a manual jerky gun with a 1/4-inch by 1-inch nozzle onto polyscreen sheets and then thermally processed in a commercial smokehouse (Table 1). A replication consisted of both inoculated batches and a control batch placed in the smokehouse simultaneously. Three replications were conducted.

***E. coli* O157:H7 and *Salmonella* Enumeration**. Raw inoculated samples were taken from the inoculated jerky batter. Heat-treated samples were taken at six different times (end of stages 6, 7, 8, 10; 1.5 hours into stage 12; and at the end of the stage 12; Table 1). Population levels of *E. coli* O157:H7 and *Salmonella* were determined for both raw and heat-treated samples. In addition, heat-treated samples with counts below the detection limit were tested for a positive or negative level of either *E. coli* O157:H7 or *Salmonella*.

Water Activity (a_w), pH, Proximate Analysis, and Salt. Water activity and pH levels were determined on control samples. Samples for proximate analysis (moisture, fat, and protein) and salt content were taken from the non-inoculated raw control batch 1.5 hours into stage 12 and at the end of stage 12 (final).

Results and Discussion

For all *E. coli* O157:H7- and *Salmonella*-inoculated jerky strips, initial raw batter populations ranged from 7.3 to 7.4 log cfu/g and 7.1 to 7.5 log cfu/g, respectively. When the product reached stages 6, 7, 8, and 10, *E. coli* O157:H7 populations ranged from less than 1.48 (detection limit) to 2.68 log cfu/g and *Salmonella* counts ranged from less than 1.5 to 2.1 log cfu/g. By 1.5 hours into stage 12, counts were consistently less than 1.5 log

cfu/g on all media. End-product *E. coli* O157:H7 and *Salmonella* populations were consistently <0.5 log cfu/g.

There was ≥ 5.0 log cfu/g reduction of *E. coli* O157:H7 at all sampling times as required by USDA/FSIS, with the most consistent reductions being after stage 7. A ≥ 6.5 log cfu/g reduction of *Salmonella*, as mandated by USDA/FSIS, was seen in stage 12 and at the end of the cycle (Figure 1). End product populations for both *E. coli* O157:H7 and *Salmonella* show reductions well above those mandated by USDA/FSIS.

Samples from 1.5 hours into stage 12 and end-product samples showed negative populations for both *E. coli* O157:H7 and *Salmonella* for all samples tested, confirming the likelihood that pathogens are dead as opposed to heat-injured.

Moisture content ranged from 52.4 to 56.0% for raw product and 15.1 to 19.8% for the final product. Protein content ranged from 15.9 to 17.0% for raw product and 34.2 to 37.7% for the final product. Salt contents for raw products ranged from 2.2 to 2.3% and from 4.2 to 5.2% for final product. The moisture-to-protein ratio ranged from 0.4 to 0.6 for the final product. This ratio is in compliance with the requirement of an MPR less than 0.75:1 needed for the product to be labeled as "jerky".

Raw batter pH values ranged from 6.0 to 6.2. The final pH range for all products was 5.1 to 5.3. It should be noted that a lowered pH was not a determining factor for the reduction of *E. coli* O157:H7 or *Salmonella* populations.

Water activity range for all final products was 0.570 to 0.625. According to the USDA/FSIS Jerky Compliance Guidelines, water activity for jerky products should be ≤ 0.80 to ensure lack of microbial growth.

Implications

A thermal process for producing chopped and formed jerky provided proper lethality to control pathogens such as *E. coli* O157:H7 and *Salmonella* and provides a process that will produce safe jerky for consumers.

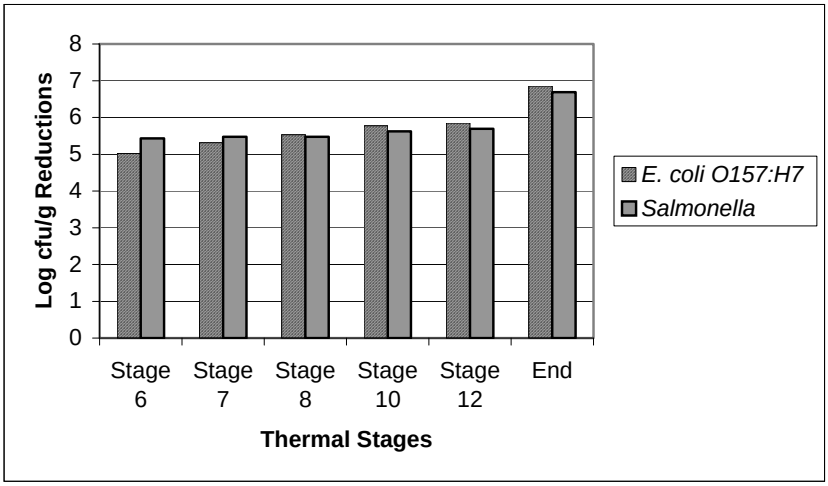

Figure 1. *E. coli* O157:H7 log CFU/g Reductions and *Salmonella* Reductions at Six Thermal Stages[a] during Production of Chopped and Formed Beef Jerky.

[a]Times and dry bulb smokehouse temperatures for thermal stages: stage 6 – 44 min at 132ºF and 46 min at 172ºF, stage 7 – 44 min at 132ºF and 1 hour at 172ºF, Stage 8 – 44 min at 132ºF and 1 hour 16 min at 172ºF, stage 10 – 44 min at 132ºF and 1 hour 46 min at 172ºF, stage 12 – 44 min at 132ºF and 3 hours 30 min at 172ºF, End – 44 min at 132ºF and 7 hours at 172ºF.

Table 1. Thermal Processing Schedule[a] and Sampling Times for Chopped and Formed Beef Jerky

Stage	Dry Bulb (D.B.) (ºF)[a]	Time	Blower Speed	Sampling Time	Cumulative Times and Temperatures at Each Sampling Time
1	132	14 min	Medium		
2	132	16 min	Medium		
3	132	14 min	Medium		
4	172	16 min	Medium		
5	172	14 min	Medium		
6	172	16 min	Medium	End of stage	44 min at 132ºF and 46 min at 172ºF
7	172	14 min	Fast	End of stage	44 min at 5132ºF and 1 h at 172ºF
8	172	16 min	Fast	End of stage	44 min at 132ºF and 1 h 16 min at 172ºF
9	172	14 min	Fast		
10	172	16 min	Fast	End of stage	44 min at 132ºF and 1 h 46 min at 172ºF
11	172	14 min	Fast		
12	172	5 h	Fast	1.5 h into stage	44 min at 132ºF and 3 h 30 min at 172ºF
End				End of stage 12	44 min at 132ºF and 7 h at 172ºF

[a]The smokehouse has an automated damper system and the ability to inject steam as needed to control humidity and the exhaust fan was running during the whole process. Percent relative humidity remained at less than 10% throughout the entire smokehouse cycle. Blower speed: Medium=788.8 ± 52.7 ft/min and fast speed = 1141.5 ± 111.9 ft/min.