

Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 1 *Cattleman's Day (1993-2014)*

Article 497

1997

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Recommended Citation

Estrada-Munoz, R.; Boyle, Elizabeth A.E.; and Marsden, James L. (1997) "Liquid smoke effects on *Escherichia coli* O157:H7 in beef trimmings and ground beef patties," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 1. <https://doi.org/10.4148/2378-5977.1900>

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**LIQUID SMOKE EFFECTS ON
ESCHERICHIA COLI O157:H7 IN BEEF
TRIMMINGS AND GROUND BEEF PATTIES**

R. Estrada-Muñoz, E.A.E. Boyle, and J.L. Marsden

Summary

Liquid smoke (LS) reduced *Escherichia coli* O157:H7 counts in inoculated beef trimmings and ground beef patties. The counts were reduced ($P < .05$) by $.5 \log_{10}$ cfu/g immediately after beef trimmings were treated with 8% LS and by 1.2, 2.0, 1.6, and 2.3 $\log_{10}$ cfu/g after the trimmings were formed into patties and tested or stored under refrigeration for 1, 2, and 3 days, respectively (2 $\log_{10}$ reduction represents 99%). Thus, LS could make beef-containing products safer with respect to foodborne pathogens.

(Key Words: Liquid Smoke, *Escherichia coli* O157:H7, Ground Beef.)

Introduction

Recently, outbreaks of foodborne illness and deaths associated with ground beef containing *E. coli* O157:H7 have occurred in the United States. *E. coli* O157:H7 is the third or fourth most common pathogen recovered from human stool samples and was first recognized as a foodborne pathogen in 1982. Since that time, undercooked ground beef has been implicated in outbreaks of *E. coli* O157:H7 infections.

Smoking of food provides a desirable flavor and color, but also contributes substantially as an antimicrobial agent. As a food additive, it has the advantage of being labeled as a natural product.

Preliminary experiments evaluated the antibacterial properties of liquid smoke (LS) in a model system. The LS inhibited *E. coli* O157:H7 growth at all levels (6-12%) evaluated in preliminary studies (data not shown). Its

bactericidal activity increased with concentration.

Based on those preliminary findings, our objective was to evaluate the bactericidal effects of adding 8% LS to beef trimmings inoculated with *E. coli* O157:H7, which were then used in production of experimental ground beef patties.

Experimental Procedures

A low-flavor-profile LS provided by Hickory Specialties was used. Fresh beef trimmings (4 days postmortem) were inoculated with a strain of *E. coli* O157:H7 resistant to the antibiotic Rifampicin to give a target of 1×10^7 cfu/g and mixed for 4 min using a Hobart mixer. The LS or sterile water (control) was added at 8% to the inoculated trim, and each mixed for 4 min. A second uninoculated control was mixed for 4 min and used for psychrotrophic counts. Then all treatments were coarsely ground (1.27 cm), followed by a fine grind (.32 cm), using a sterile grinder. Patties (70-90 g) were made using a manual patty maker, bagged aerobically in heat-sealed bags, and stored in the dark at 4°C for up to 3 days. Three replications were performed.

Immediately after inoculation, duplicate 25 g surface samples were taken from inoculated beef trimmings, from treated (LS and water) beef trimmings, and from noninoculated beef trimmings to check initial *E. coli* O157:H7 population, antibacterial effects of treatment of trimmings, and psychrotrophic counts. The surface samples (approx. .7 cm deep) were taken using a sterile scalpel and tongs. Duplicate 25 g samples were taken from the LS-treated patties, inoculated control patties, and noninoculated control patties at days 0, 1, 2 and 3. Each sample was placed in a filter stomacher bag, 225 ml of .1% of peptone water was

added, and the mixture was stomached for 2 min. Serial dilutions were prepared in peptone water (.1%) and spiral plated on MacConkey sorbitol agar containing Rifampicin (inoculated samples) or on plate count agar (noninoculated control samples). The plates for inoculated samples were incubated at 37°C for 24 hr, and the plates for noninoculated samples were incubated at 7°C for 10 days for psychrotrophic counts. A Laser Spiral System Bacterial Colony Counter was used to count colonies growing on or in the culture medium and reported as log₁₀ cfu/g of sample.

The statistical design was a split-plot design, with meat block was the whole plot and the meat sample each day from the meat block as the subplot. Significance level was set at $P < .05$. Analysis of variance and least significant difference procedures were used.

Results and Discussion

Adding 8% LS to beef trimmings inoculated with *E. coli* O157:H7 and later ground inhibited *E. coli* O157:H7 growth (Figure 1). The *E. coli* O157:H7 counts were lower in treated inoculated beef patties than controls ($P < .05$) from day 1 to day 3. In untreated inoculated beef patties (control), *E. coli* O157:H7 counts did not change ($P > .05$).

E. coli O157:H7 counts were reduced ($P < .05$) by .5 log₁₀ cfu/g, after beef trimmings were treated with 8% LS and by 1.2, 2.0, 1.6, and 2.3 log₁₀ cfu/g in patties made from the trimmings before (0 day) and after 1, 2 and 3 days of refrigerated storage, respectively. The psychrotrophic counts in beef trimmings and ground beef remained constant from day 0 to day 1, but increased rapidly from day 1 to day 3. Psychrotrophic bacterial growth did not impact *E. coli* O157:H7 growth. *E. coli* O157:H7 growth was not affected by meat fat content in treated or untreated beef patties (data not shown). Thus, 8% LS was effective in reducing *E. coli* O157:H7 counts in ground beef patties.

The level of LS we used was higher than normally recommended (1.5-2.0%) for meat products. However, adding 8% LS to beef trimmings could be feasible as a food safety tool for sausage production if the trimmings are only one component of the product formulation. For instance, if beef trimmings were treated with 8% LS, and the sausage contained 25% beef, the LS level would be reduced to a level normal for a meat product. Liquid smoke is used in meat mainly to provide flavor and color. However, because of its antimicrobial characteristics, LS could be added to meat products to make them safer and at the same time to extend product shelf-life. Further research should examine the antimicrobial properties of LS in meat systems.

Figure 1. Growth of *E. coli* O157:H7 in Beef Trimmings Inoculated, Ground, Treated with 8% Liquid Smoke, and Stored at 4°C. (AI = after inoculation, AT = after treatment, AG = after grinding). S.E. = .15. ab = Means with same letter are not different ($P > .05$).

