A Research Note

Bacteriology of Restructured Lamb Roasts Made with Mechanically Deboned Meat

BIBEK RAY* and R. A. FIELD

Animal Science Division, University Station Box 3354, University of Wyoming, Laramie, Wyoming 82071

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ABSTRACT

Composite samples of restructured lamb roast containing 10 or 30% mechanically deboned meat (MDM) were analyzed for bacteriological quality before and after cooking to 62.8°C (145°F). Uncooked samples had less than 3.0 x 10^6 colony forming units/g mesophilic and psychrotrophic aerobes and anaerobes including lactobacilli. In general, these groups, as well as coliforms and fecal coliforms, were present in higher numbers in uncooked roasts containing higher percentages of MDM. Staphylococcus aureus, Clostridium perfringens, Salmonella sp., Yersinia enterocolitica and Campylobacter jejuni were not detected in uncooked samples. Cooking reduced the number of aerobic and anaerobic spoilage bacteria and eliminated index bacteria (in 0.1 g) effectively.

Production of mechanically deboned meat (MDM) from beef, lamb and pork is expected to increase in the United States in the very near future (2). It will primarily be used in the development and marketing of many types of processed meat products. Since MDM has higher pH, lipids and bone marrow than hand-boned meat (2) and because of its fine particle size, microbiological considerations during production and subsequent handling of MDM, as well as the influence of its inclusion on shelf-life and health hazards of the processed products, have to be evaluated.

A study was undertaken in our laboratory to determine the feasibility of incorporating MDM from lamb into restructured lamb roast. Many parameters, such as percentage of MDM, ingredient composition, cooking temperature, cooking loss, texture, palatability and lipid degradation, were studied. Bacteriological quality of uncooked roasts and the influence of cooking roasts to 62.8°C (145°F) on natural flora were also determined and we report these results in this note.

MATERIALS AND METHODS

Collection of samples

Fifty choice and prime grade lambs weighing approx. 110 lb. (49.9 kg) were slaughtered in two groups of 25 each at the R. H. Hunska U.S. Meat Animal Research Center, Clay Center, NE, and hot-boned 2 h after stunning. Meat and bones were chilled immediately after boning and stored in separate sterile plastic bags before transporting to the meat laboratory at the University of Wyoming. Internal temperature of the meat and bones when they reached the University meat laboratory was 1.1°C. Bones muscles were ground through a 3.8-cm kidney plate and mixed to ensure homogeneity of the meat. Roughtly trimmed bones with neck and shank meat attached were ground through a 1.3-cm plate and then mechanically deboned using a Beehive deboner equipped with a head possessing 0.46 mm diameter holes in its cylinder. The MDM, which contained 0.33% calcium, was chilled immediately and held at 1.1°C overnight. The next morning (within 24 h after slaughter) required amounts of lean and MDM were mixed to obtain roasts containing 10 or 30% MDM. Other conditions were added in identical amounts to both types of roasts.

Three uncooked roasts from each lean:MDM mixture from each group of lambs were collected and immediately analyzed for bacteriological quality. The raw mixtures were stuffed into 8.8 cm diameter cellulose casings and the roasts were cooked in an oven initially at 60°C for 2 h, then at 71.1°C for 2 h and finally at 82.2°C until the internal temperature of the roasts reached 62.8°C in about 6 h. The roasts were cooled to 32.2°C with a cold water spray within 30 min after reaching 62.8°C and then refrigerated at 4.4°C. Internal temperature of the roasts reached 4.4°C within 8 h. Two roasts containing 10% MDM and two containing 30% MDM from each group of lambs were used for bacteriological analysis. All equipment and facilities were properly sanitized.

Bacteriological analysis

Representative 100 g portions from each sample were blended aseptically with 400 ml of 0.1% peptone water for 3 to 4 min. In general, recommended methods were used for enumeration, isolation and biochemical testing of most bacterial groups or species (3,4); however, different methods were used for enumeration of coliforms and fecal coliforms (3,5) and for isolation of Campylobacter jejuni (4,7). Brief descriptions of the procedures are included here. A 50-ml portion of blended sample was mixed with 50 ml of 0.1% peptone water and used for plating, after serial dilution, for enumeration of different bacteria. For plating with plate count agar (PCA) was used for the mesophilic and psychrotrophic aerobes and anaerobes. Plates were incubated at 37°C for 2 d for mesophiles and at 10°C for 7 d for psychrophiles; a N2 atmosphere was used to incubate anaerobes. For psychrotrophic lactobacilli, pour plating followed by overlaying with APT agar and 7 d incubation at 10°C under N2 were used. Representative colonies were examined for long, non-motile, slender rods using a phase-contrast microscope. Coifloms and fecal coifloms were enumerated by plating the diluted samples with 5 ml PCA, incubating at room temperature (22 to 23°C) for 1 h and overlaying with 10 to 12 ml of violet red bile agar. Plates were incubated for 24 h at 37°C for coliforms and at 45°C for fecal coliforms (3,5). Typical colonies were counted. For coliform confirmation, up to 12 representative colonies for each sample were transferred to brilliant green lactose bile broth (BGLB) tubes, incubated up to 48 h at 37°C and examined for gas formation. A
TABLE 1. Bacterial counts in restructured roasts containing 10 and 30% mechanically deboned meat (MDM).

<table>
<thead>
<tr>
<th>Bacterial groups or species</th>
<th>Uncooked</th>
<th>Cooked</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10%b</td>
<td>30%b</td>
</tr>
<tr>
<td></td>
<td>(n = 6)</td>
<td>(n = 6)</td>
</tr>
<tr>
<td>Mesophilic aerobes (APe)</td>
<td>4.37 ± 0.39</td>
<td>4.45 ± 0.18</td>
</tr>
<tr>
<td>Mesophilic anaerobes</td>
<td>4.35 ± 0.40</td>
<td>4.43 ± 0.39</td>
</tr>
<tr>
<td>Psychrotrophic aerobes</td>
<td>3.93 ± 0.59</td>
<td>4.12 ± 0.31</td>
</tr>
<tr>
<td>Psychrotrophic anaerobes</td>
<td>4.00 ± 0.59</td>
<td>4.05 ± 0.28</td>
</tr>
<tr>
<td>Psychrotrophic lactobacilli</td>
<td>3.60 ± 1.18</td>
<td>3.68 ± 0.31</td>
</tr>
<tr>
<td>Coliforms</td>
<td>2.37 ± 0.58</td>
<td>2.97 ± 0.74</td>
</tr>
<tr>
<td>Fecal coliforms</td>
<td>1.68 ± 0.99</td>
<td>2.25 ± 0.51</td>
</tr>
<tr>
<td>Staphylococci/micrococi</td>
<td>2.68 ± 0.39</td>
<td>2.77 ± 0.15</td>
</tr>
<tr>
<td>Clostridium perfringens</td>
<td>&lt;1.00g</td>
<td>&lt;1.00g</td>
</tr>
</tbody>
</table>

Salmonella sp.                | absent   | absent  | -      | - |
Yersinia enterocolitica       | in       | in      | -      | - |
Campylobacter jejuni          | 25 g     | 25 g    | not tested | - |

*aLog colony forming units/g except for Salmonella, Y. enterocolitica and C. jejuni.
*bValues are means ± standard deviations.
*cT-values exceeding 2.2 are significantly different (P<0.05).
*dLess than 30 CFU/g.
*e0 in 1 g except for staphylococci which were <10/g in cooked products.

similar method was used to confirm fecal coliforms, but the tubes were incubated at 45°C for 48 h. Original plate counts were corrected for colonies forming gas. Staphylococci were enumerated by surface plating 0.1 to 0.5 ml diluted samples on Vogel and Johnson (VJ) prepared agar plates followed by 2 d of incubation at 37°C. Medium to large black colonies were enumerated. Up to 10 colonies from each sample were examined for coagulase reaction. For enumeration of Clostridium perfringens, diluted samples were pour plated with tryptose-sulfite cycloheximide agar and the plates were incubated for 24 h at 37°C in N2.

For isolation of Salmonella sp., a 25 g equivalent of blended sample was preenriched in lactose broth for 24 h at 37°C; a 10-ml portion was enriched in 90 ml of selenite cystine broth at 37°C for 24 h and a loopful of material was streaked on plates of xylose-lysine deoxycholate (XLD) agar and brilliant green (BG) agar. Plates were incubated at 37°C for 24 h and 1 to 2 suspect colonies from each plate were screened biologically through reactions in triple sugar iron agar slants, lysine iron agar slants, dulcitol broth and urea broth. For Yersinia enterocolitica isolation, blended materials, equivalent to a 25-g sample, were enriched in phosphate buffer at 4°C for 21 d. One milliliter was then transferred to 10 ml of MgCl2-malachite green-carbonic acid medium, incubated at 25°C for 2 d and a loopful of material was streaked on MacConkey agar and bismuth sulfite agar plates. The plates were incubated at 25°C for 48 h and 1 to 2 suspect colonies from each plate were biologically screened by the following tests: cytochrome oxidase, lysine decarboxylase, urease, citrate utilization and motility at 25 and 36°C. For Campylobacter jejuni isolation, 125 ml of blended sample were centrifuged at 10,000 x g for 30 min and the pellet was resuspended in 100 ml of VTP broth (brucella broth) with vancomycin, 7.5 mg/L; trimethoprim, 3.75 mg/L; and polymyxin B 1,500 units/L. The broth was incubated quiescently at 42°C for 2 d in a special atmosphere of 5% O2:10% CO2:85% N2. About 10 ml of broth were then filtered through sterile fluted paper (grade 512) and a loopful of filtrate was streaked on a VTP agar plate (VTP broth + 1.5% agar) containing 5% defibrinated sheep blood. The plates were incubated at 42°C for 2 d in the special atmosphere described earlier. Typical colonies were screened as follows: cell morphology under a phase-contrast and dark field microscope, growth at 42 and 25°C, and oxidase and catalase activity.

RESULTS AND DISCUSSION

Uncooked products had mesophilic and psychrotrophic counts not exceeding 3.0 x 10^4 CFU/g (Table 1). Although statistically insignificant, these bacteria were present in relatively higher numbers in products containing higher amounts of MDM. Coliforms and fecal coliforms were present in higher numbers, especially in products containing 30% MDM. Analysis of indicators, viz., lean meat, MDM and condiments, revealed the source of coliforms and fecal coliforms in roasts to be MDM (data not included). Higher counts of indicator and other groups of bacteria were expected in MDM than in hot-boned lean because hot-boned lean had the fat and fat over exposed surfaces removed. Exposed surfaces are places where contamination normally occurs during the dressing procedure. Mechanically deboned meat, in contrast, was produced from bones which had shank meat attached. The surface of shank meat is especially vulnerable to contamination during slaughtering and this surface contamination undoubtedly contributed to the higher bacterial counts in MDM. Another probable source of coliforms and fecal coliforms in MDM was the pelvic region that is easily contaminated with fecal materials during evisceration. This observation implies that unless proper sanitary care is taken in dressing, shanks and the pelvic region could be sources of pathogens, especially of gastrointestinal origin, in MDM.

Staphylococcus aureus and C. perfringens were not detected in the uncooked products (0 in 0.1 g). Black colonies on VJ agar plates were coagulase-negative and thus, were reported as staphylococci/micrococci. The uncooked products were also negative for Salmonella, Y. enterocolitica and C. jejuni in 25-g samples. Suspect colonies from respective plating media gave negative biochemical profiles for those three pathogens.

Cooking roasts to an internal temperature of 62.8°C reduced mesophilic and psychrotrophic counts to less than 30/g and eliminated coliforms and fecal coliforms in 0.1-g samples. The latter data suggested that cooking to 62.8°C...
would effectively eliminate pathogens, especially those with similar heat sensitivity as coliforms and fecal coliforms. Some staphylococci were present in cooked products. Cooked products were tested for \textit{C. perfringens} to detect any heat surviving spores; but all samples tested were negative. Because uncooked products were negative for \textit{Salmonella}, \textit{Y. enterocolitica} and \textit{C. jejuni}, cooked products were not tested for these pathogens.

Overall bacteriological quality of restructured lamb roasts produced from hot-boned meat and MDM from the same lambs was excellent. This might be a reflection of the sanitary care used during slaughtering and subsequent handling and processing of materials. We believe the higher coliforms and fecal coliforms in MDM were a result of contamination of shanks and the pelvic region during slaughter and evisceration. This emphasizes the importance of sanitation on the kill floor, especially if materials are used to produce MDM.

ACKNOWLEDGMENTS

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REFERENCES