Microbiological and Organoleptic Qualities of Bruised Meat

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ABSTRACT

Naturally bruised tissues from the carcasses of cattle and sheep slaughtered and processed at a commercial abattoir were compared with unbruised tissues from similar areas of the same carcasses. There were no microbiological differences between the two types of tissue when bruised tissues were subject to the same conditions as unbruised tissue during processing of carcasses. Bruised tissue had a slightly higher water content and imparted a salty taste to minces prepared from it. However, the presence of bruised tissue was not detected organoleptically when it was added at a level of 10% to unbruised mince.

Meat hygiene regulations require bruised tissue to be removed and condemned before carcasses are regarded as fit for human consumption. This requirement appears to be based on two assumptions: that bruised tissue is removed and condemned before carcasses are regarded from the intestine via the blood or lymphatic systems, and that bacteria can grow more rapidly on bruised than on healthy tissue (10,11). However, it is now clear that deep muscle tissue from healthy animals is normally sterile (5), and many organisms grow at their maximum rate on unbruised tissue (6). Moreover, a study of both experimentally induced and naturally occurring bruises showed that deep contamination of bruises did not occur and that bacteria grew at the same rate on bruised and unbruised tissues. Although bruised tissue collected from a commercial operation was more heavily contaminated than unbruised tissue, this arose because of greater handling of the bruised tissue. Provided bruised and unbruised tissues were processed in a similar way, there appeared to be no difference in their microbiological condition (7).

These results suggest that the requirement for rapid removal of bruised tissue may be unnecessary. Abandonment of the requirement would at the least affect some saving on abattoir costs as the expense and inconvenience of moving bruised carcasses from slaughter to detain rails could be avoided by removing bruises during breaking down of carcasses. It might also be possible to utilize bruised tissue in minces or manufactured products. The objective of this work was to obtain data on the acceptability for human consumption of bruised tissue from commercial carcasses.

MATERIALS AND METHODS

Compositional and quality of bruised tissue removed from beef carcasses during normal commercial operation of an abattoir

During 2 days of operation of an abattoir, all carcasses detained on meat inspectorate instructions for removal of bruised tissue were examined. The Australian carcass bruise scoring system was used to categorize the degree of bruising according to the surface diameter of bruised areas as slight (2 to 8 cm), medium (8 to 16 cm), or heavy (> 16 cm) (4). Bruised tissue was then removed by works personnel and collected. At the end of each day’s slaughter, the bruised tissue was taken to the laboratory where excess fat was trimmed off and discarded after weighing. The remaining tissue was minced twice to ensure thorough mincing; first through a coarse then a fine plate with hole diameters of 10 and 3 mm, respectively. Two 25-g samples were homogenized by stomaching each with 225 ml of 0.1% (w/v) peptone solution. The homogenates and serial 10-fold dilutions in 0.1% peptone solution were used for microbiological analysis. All plate counts were made in duplicate for each homogenate.

Total counts and counts of mesophiles were determined by spreading 0.1-ml samples on nutrient agar and incubating plates for 72 h at 25°C and for 24 h at 37°C, respectively.

Escherichia coli was estimated by the Anderson-Baird Parker method (2). Filters overlaying tryptone bile agar were inoculated with 1-ml samples and incubated at 44.5°C for 24 h.

Enterobacteriaceae were estimated from pour plates of violet red bile (VRB) agar plus 1% glucose inoculated with 1-ml samples and incubated at 44.5°C for 24 h. VRB agar and incubated at 37°C for 24 h and 25°C for 72 h.

Fecal streptococci were estimated from pour plates of blood agar inoculated with 1-ml samples and incubated at 37°C for 24 h under an atmosphere of 90% N₂ plus 10% CO₂.

Staphylococcus aureus was estimated on Baird-Parker Medium (3) spread with 0.1-ml samples and incubated at 37°C for 24 h. Shiny black colonies surrounded by a white margin and zone of clearing were presumed to be Staphylococcus aureus.

Clostridium perfringens was estimated on Shahidi-Ferguson perfringens (SFP) agar spread with 0.1-ml samples and overlayed with 10 ml of SFP overlay agar (13). After incubation at 37°C for 24 h in an anaerobic atmosphere, black colonies surrounded by zones of opaque precipitate were presumed to be Clostridium perfringens.

For detection of Salmonella, 10 g of mince were added to 100 ml of tetraphionate brilliant green broth and incubated at 37°C for 24 h. Loops full of the enrichment broth were transferred to duplicate plates.
of brilliant green (BG) and xylose lysine desoxycholate (XLD) agar, which were incubated at 37°C for 24 h. Presumptive positive colonies (pink or red surrounded by red zones on BG; red often with black centers on XLD) were transferred to tubes of triple sugar iron agar (TSI) and lysine broth (LB). Both were incubated at 37°C for 24 h. Colonies giving an alkaline (purple) reaction in LB and red slant, yellow butt on TSI agar were assumed to be Salmonella.

Comparison of bruised and unbruised tissue from carcasses not subjected to removal of bruised tissue soon after slaughter

Carcasses (9 beef, 10 lamb) showing substantial bruising were identified when they were skinned during normal abattoir operations. The butchering of these carcasses was completed without removal of the bruises. The carcasses were held at 10°C for 24 h on the abattoir cooling floor. The bruised surfaces and similar unbruised areas of each carcass were sampled for total bacterial counts, both before and after removal from each conditioned carcass by abattoir personnel. The bruises. The carcasses were held at 10°C for 24 h on the abattoir conditioning, by swabbing areas of 5 cm². The bruised tissue and a similar quantity of unbruised tissue from a comparable area were removed from each conditioned carcass by abattoir personnel. The bruised and unbruised tissue from each carcass were separately collected.

Each sample of bruised and unbruised tissue was separately minced. Samples of each mince (10 g) were homogenized and diluted samples of homogenate spread on nutrient agar for determination of total counts. Water contents were determined by drying 1-g samples at 80°C to constant weight. Fat contents were determined by extraction of 5-g samples with 50 ml of chloroform:methanol (2:1 v/v), filtering through fiberglass paper, removing the solvent in a rotary evaporator and weighing the residual lipid. Bilirubin was estimated as azobilirubin after extraction of 5 g of mince with chloroform (9). Total heme pigments (hemoglobin and myoglobin) were estimated spectrophotometrically from the extinction at 540 nm of aqueous extracts of minces treated with solutions of potassium ferricyanide and cyanide to convert heme pigment to the cyanomet-compounds (4).

Sensory evaluation of minces

The minces used in comparison of bruised and unbruised tissue were combined to give four bulk minces; viz. beef bruised, beef unbruised, mutton bruised, mutton unbruised. The appearances of minces were examined both before and after cooking. The taste of bruised tissue minces, alone or mixed with various proportions of unbruised tissue minces, was compared with the taste of unbruised tissue minces. Samples were fried in vegetable fat (20% of mince weight) at 106°C for 5 min and evaluated in triangle tests by a taste panel of 20 members.

RESULTS

Quality and composition of bruised tissue removed from beef carcasses during normal commercial operation of an abattoir

Approximately 200 cattle were killed each day with 11% and 22% being passed to the detain rail for removal of bruised tissue on the first and second days, respectively. Bruising was generally light, only 12 carcasses showing heavy bruising. Tissue removed averaged only 1 kg per bruised carcass and 60% to 70% of this was subcutaneous fat cover (Table 1). The mince prepared each day from all meat recovered from bruised tissue was of acceptable microbiological quality with no evidence that presumed pathogens were present in numbers any greater than are usually found in minces (Table 2).

Comparison of bruised and unbruised tissue from carcasses not subject to removal of bruised tissue soon after slaughter

There was no significant difference between swab counts from bruised and unbruised areas of the carcasses immediately after dressing. Swab counts from either type of surface had not altered significantly after chilling. Minces subsequently prepared from bruised and unbruised tissues had similar bacterial loads. Bruised tissue minces appeared to have a slightly higher water content than minces of unbruised tissue. This difference was accentuated when the water contents were adjusted for variation in the fat content as bruised tissue minces tended to have a higher proportion of fat. Bilirubin was not detected in any of the minces. Bruised tissue minces had higher contents of heme pigments than those from unbruised tissue (Table 3).

Sensory evaluation of minces

Minces prepared from bruised tissue had a more
TABLE 3. Comparison of the microbiological condition and composition of bruised and unbruised tissues from individual carcasses (9 beef, 10 mutton). Each sample of bruised and unbruised tissue from each carcass was separately examined. Counts from dressed and chilled carcasses were obtained by swabbing carcass surfaces. Counts for minces were obtained from homogenates of mince samples.

<table>
<thead>
<tr>
<th>Test</th>
<th>Beef Unbruised Mean (range)</th>
<th>Beef Bruised Mean (range)</th>
<th>Mutton Unbruised Mean (range)</th>
<th>Mutton Bruised Mean (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>After dressing (No/cm²)</td>
<td>3.8(10.0-1.2) x 10²</td>
<td>3.6(13.0-0.4) x 10²</td>
<td>2.4(6.4-0.6) x 10³</td>
<td>2.5(6.0-0.9) x 10³</td>
</tr>
<tr>
<td>After chilling (No/cm²)</td>
<td>2.2(7.8-0.2) x 10²</td>
<td>2.4(10.0-0.2) x 10²</td>
<td>1.9(5.5-0.2) x 10³</td>
<td>1.6(6.6-0.7) x 10³</td>
</tr>
<tr>
<td>Mince (No/g)</td>
<td>3.7(8.4-0.8) x 10²</td>
<td>3.2(8.0-0.6) x 10²</td>
<td>7.3(11.0-1.8) x 10⁴</td>
<td>9.3(32.0-0.7) x 10⁴</td>
</tr>
<tr>
<td>Fat (% wet wt)</td>
<td>5.4(7.8-2.9)</td>
<td>3.5(6.0-0.8)</td>
<td>14.0(20.5-8.7)</td>
<td>16.2(19.5-10.2)</td>
</tr>
<tr>
<td>Water (% wet wt)</td>
<td>74.1(79.8-70.1)</td>
<td>72.4(74.1-68.2)</td>
<td>72.1(73.8-66.2)</td>
<td>64.8(71.3-60.8)</td>
</tr>
<tr>
<td>Water (fat%)</td>
<td>79.2(85.5-73.0)</td>
<td>74.9(78.7-71.3)</td>
<td>81.4(85.7-75.0)</td>
<td>77.3(82.4-72.5)</td>
</tr>
<tr>
<td>Heme pigments (mg heme/g)</td>
<td>5.3(6.0-3.7)</td>
<td>3.7(5.3-2.0)</td>
<td>5.0(6.2-3.9)</td>
<td>4.5(5.8-3.1)</td>
</tr>
</tbody>
</table>

intense red color and therefore a more attractive appearance than minces from unbruised tissue. The bruised tissue minces were darker brown than the unbruised tissue minces after they had been cooked. The color intensity was diluted in proportion to the amount of unbruised material mixed with the bruised. Raw minces containing 25% of bruised tissue could not be distinguished by color from the unbruised mince, but the minces could be differentiated after cooking by the darker color of the mince containing bruised tissue.

Unmixed bruised tissue minces could be distinguished by a flavor described as “metallic” or “salty”. With mutton this difference disappeared when the bruised tissue was mixed with an equal quantity of unbruised tissue as no significant differences were found in triangle tests between unbruised tissue minces and minces containing 50% or 25% of bruised tissue. There was greater discernment of the bruised tissue taste in beef minces, and the presence of bruised tissue was detected at the 25% level but not at the 10% level (Table 4).

TABLE 4. Triangle tests by a taste panel of 20 members on minces containing bruised tissue.

<table>
<thead>
<tr>
<th>Test (% wt of bruised tissue)</th>
<th>Number correctly identifying odd sample</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef</td>
<td>Mutton</td>
<td>Beef</td>
</tr>
<tr>
<td>0 vs 50</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>0 vs 25</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>0 vs 10</td>
<td>10</td>
<td>.a</td>
</tr>
</tbody>
</table>

a. Not tested.

DISCUSSION

The microbiological conditions of minces prepared from bruised tissues removed during normal abattoir operation were well within acceptable limits for total counts and presumptive counts for specific pathogens (12). The absence of any difference in the microbiological status of bruised and unbruised tissue from commercial carcasses confirms the previous observation with experimental animals (7), that bruised tissue presents no increased microbiological hazard provided that it is handled in the same manner as unbruised tissue. There can therefore be no justification for the present requirement for early removal of bruising on the killing floor. It is possible that bruises associated with deep wounds (i.e. wounds that penetrate the hide and reach the underlying muscle) could be heavily contaminated with bacteria, but such cases seem to be very rare and should be detected during routine inspection. It is difficult to believe that deep wounds could escape detection sufficiently frequently and in such numbers as to justify the wholesale condemnation of all bruised tissue.

Bruised tissue would clearly have to be removed from prime cuts for aesthetic reasons, but since there is no significant health hazard associated with it, it could be used in minces and manufactured products. The use of bruised tissue in human food should be determined only by its acceptability to the consumer. The only differences detected between bruised and unbruised tissues were the somewhat increased water and heme content and salty taste of the former. The failure to detect bilirubin in bruised tissue, which may also account for the salty taste. This taste is more marked in flavored meat like beef, but bruised tissue would be undetectable as a minor fraction (< 10%) of any unflavored prepared meat and higher levels could be used in strongly flavored products.

In New Zealand, losses due to bruising are relatively small because stock is not usually transported over long distances and continuing action by the supervising authority encourages good stock handling procedures. However, where conditions are different, bruising can cause substantial economic losses (14,15). It is obvious that there will always be some cost associated with
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bruising, so on economic as well as humanitarian grounds it is desirable that bruising is prevented. However, some degree of bruising is unavoidable, so the economic cost should be minimized, particularly as this will ultimately be borne by the consumer. Losses associated with bruising could be reduced substantially if the untenable hypothesis that bruised tissue is a health hazard was abandoned and bruising was treated purely as a commercial problem.

ACKNOWLEDGMENTS

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REFERENCES


Anderson et al., con’t. from p. 645