Meat from dairy cows: possible microbiological hazards and risks

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Summary
The authors provide an overview of the circumstances associated with culling of dairy cattle in the United States of America (USA) and focus on the possible significant microbiological hazards associated with meat from cull dairy cows. Cull dairy cows are an important source of food in the USA, accounting for at least approximately 17% of ground beef. The potential microbiological hazards for foodborne illness from cull dairy cows discussed here include Salmonella (with special attention to S. Typhimurium DT104), Escherichia coli O157:H7, Campylobacter jejuni, Listeria monocytogenes, Clostridium perfringens and Staphylococcus aureus. Possible sources and means of contamination are pointed out, as are the potential foodborne risks from Bacillus cereus and Aeromonas spp. In conclusion, widespread microbiological studies are needed to determine the prevalence and risk of foodborne pathogens in cull dairy cattle.

Keywords

Introduction
There is currently a dynamic national appraisal of foodborne illness and methods of prevention in the United States of America (USA). This appraisal has been particularly intense since late 1992, when a major outbreak of Escherichia coli O157:H7-induced foodborne illness, associated with the consumption of undercooked ground beef, occurred in the northwestern USA.

In the USA, a significant amount of beef is obtained from dairy cows (70). Dairy cows account for approximately 8% to 10% of cattle slaughtered annually in federally inspected slaughter facilities (69). Meat from dairy cows is a significant source of ground beef. For 1992, it was estimated that 34% of domestic ground beef came from (cull) cows (68). In 1992, approximately 50.7% of cows slaughtered under federal inspection were dairy cows (69). Hence, it is possible that culled dairy cows account for approximately 17% of USA ground beef production. This paper considers the possible microbiological hazards and public health risks associated with meat from cull dairy cows.

The dairy production industry in the United States of America: a brief overview

The production dairy industry in the USA is large, diverse, dynamic and productive. The national dairy cow inventory in 1996 contained approximately 9.4 million cows and heifers on approximately 140,000 operations, distributed throughout all 50 States (69). However, approximately 83% of dairy cows are located in 21 States (69, 71).

Between 1987 and 1996, the dairy cow population nationwide declined by approximately one million animals, but total milk production for roughly this period (1985-1994) increased by over 4.5 million kg, thus milk production per cow increased by 1,400 kg (69). Over 60% of dairy farms in the USA demonstrated a rolling herd average of approximately 7,300 kg (or more) of milk, and nearly 20% of dairy operations had an average milk production of 9,100 kg or greater per cow (71).
The number of larger dairy farms in the USA is increasing. In 1996, 7,000 farms maintained 200 or more milk cows: an increase of 180 farms since 1995 (69). At the same time, small farms (containing 29 to 99 cows) decreased significantly in number (69). The 15 top States ranked by dairy cow inventory are presented in Table I. The number of operations per State and the average production per cow are also included in this Table.

Table I
Top fifteen States in the United States of America ranked by dairy cow inventory and including number of operations and milk production per cow

<table>
<thead>
<tr>
<th>State</th>
<th>1994 (a) Cows and heifers which calved (1,000)</th>
<th>Number of operations (b)</th>
<th>1994 Milk per cow (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wisconsin</td>
<td>1,494</td>
<td>23,990</td>
<td>6,819</td>
</tr>
<tr>
<td>California</td>
<td>1,235</td>
<td>3,300</td>
<td>9,208</td>
</tr>
<tr>
<td>New York</td>
<td>718</td>
<td>10,000</td>
<td>7,230</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>639</td>
<td>11,800</td>
<td>7,277</td>
</tr>
<tr>
<td>Minnesota</td>
<td>609</td>
<td>12,000</td>
<td>6,973</td>
</tr>
<tr>
<td>Texas</td>
<td>402</td>
<td>3,700</td>
<td>7,039</td>
</tr>
<tr>
<td>Michigan</td>
<td>328</td>
<td>4,700</td>
<td>7,884</td>
</tr>
<tr>
<td>Ohio</td>
<td>294</td>
<td>7,500</td>
<td>6,988</td>
</tr>
<tr>
<td>Iowa</td>
<td>265</td>
<td>5,300</td>
<td>6,796</td>
</tr>
<tr>
<td>Washington</td>
<td>261</td>
<td>2,000</td>
<td>9,061</td>
</tr>
<tr>
<td>Idaho</td>
<td>208</td>
<td>1,500</td>
<td>8,204</td>
</tr>
<tr>
<td>Missouri</td>
<td>197</td>
<td>4,500</td>
<td>6,276</td>
</tr>
<tr>
<td>Florida</td>
<td>176</td>
<td>800</td>
<td>6,774</td>
</tr>
<tr>
<td>Kentucky</td>
<td>188</td>
<td>4,000</td>
<td>5,430</td>
</tr>
<tr>
<td>New Mexico</td>
<td>165</td>
<td>1,100</td>
<td>9,160</td>
</tr>
</tbody>
</table>

Modified from data presented in United States Department of Agriculture Statistics 1995-1996 (69)
(a) data originally designated as preliminary
(b) number of dairy operations in 1995

The distribution of these farms and cattle populations, and the proximity to slaughter facilities for dairy cows, may indirectly influence the risk of foodborne illness. Large slaughter facilities processing fed cattle are concentrated in the Great Plains (68). However, nationally, the number of slaughter plants processing 90% of cows decreased between 1983 and 1992 by approximately 55% (68). Thus, it is likely that many dairy cattle may be transported relatively long distances prior to slaughter (H.F. Troutt & B.I. Osburn, unpublished data).

The cull dairy cow

In North America, there are two broad classifications which categorise the culling of dairy cows: voluntary and involuntary (19, 38). Voluntary culling generally refers to culling as a result of sale to another dairy or because of decreased production; the dairy farmer voluntarily selects the cow to be culled. Involuntary culling is the consequence of culling due to a physical defect or disease condition. The implication associated with involuntary culling is that defect or disease is avoidable, and that without such a problem the cow would have been retained in the herd (19, 38). Data compiled from a number of sources (eastern USA and Canada) by Petrow (19) demonstrate that the principal reasons for involuntary culling are reproductive failure (23% of all culls), mastitis (15%) and disease or injury (10.4%). Recent information indicates that 26.5% of dairy cows are culled because of udder or mastitis problems, while 26.7% are culled for reproductive problems and 19.3% are discarded as a result of lameness, injury or disease.

Research has suggested the optimum average culling rate to be approximately 25%, lower than the national average of 'about 31%' (55). Recent data place overall cull rates between 24% and 33.2%, with slightly higher rates for larger herds (Table II) (71; J. Clay, personal communication).

Table II
Cull rates of dairy cows in the United States of America by farm size modified from two data sets

<table>
<thead>
<tr>
<th>Hard size</th>
<th>Percentage of cows culled</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NAHMS (a)</td>
</tr>
<tr>
<td>&lt; 100</td>
<td>23.9</td>
</tr>
<tr>
<td>100-199</td>
<td>22.1</td>
</tr>
<tr>
<td>200-499</td>
<td>–</td>
</tr>
<tr>
<td>500-999</td>
<td>25.1</td>
</tr>
<tr>
<td>&gt; 500</td>
<td>–</td>
</tr>
<tr>
<td>All operations</td>
<td>24.0</td>
</tr>
</tbody>
</table>

(a) Source: National Animal Health Monitoring System of the United States Department of Agriculture/Animal and Plant Health Inspection Service (71)
(b) Source: Dairy Records Processing Center, Raleigh, North Carolina (J. Clay, personal communication)

Records for cows from dairy farms in 38 States (total herds: 12,516). Between 1 January 1996 and 31 January 1997, the number of cows leaving the herd was divided by the average number of cows in the herd.

The culling rates for dairy herds in the USA range between 22% and 35% (38, 71). In 1994, the dairy cow inventory was 9,528 million animals with 2,858 million dairy cows slaughtered in federally inspected facilities, indicating that approximately 30% of the national inventory were removed for slaughter. When examining questions of food safety, these cull cows must be taken into consideration. According to United States Department of Agriculture (USDA) National Animal Health Monitoring System (NAHMS) data, 74% of cull dairy cows are 'sent to a market, auction or stockyards', while 21% are sold directly for slaughter (71). However, virtually all cull dairy cows in the USA are ultimately utilised for food purposes.
Microbiological hazards and risks

The muscle tissues of normal healthy cattle presented at slaughter are considered essentially sterile (29, 30). During slaughter, foodborne pathogens may contaminate carcasses. This contamination arises in a number of ways, including: contact with the hair coat at the time of hide removal (7); direct contact with rumen and/or intestinal contents during processing, from knives, saws and other equipment (40), and from the contaminated hands and clothing of personnel handling and processing the carcasses (7). Additionally, carcass contamination can result from airborne bacteria (51) and from inappropriate use of water in the processing environment (7). Knives, carcasses and the hands of personnel may be contaminated by contents of the mammary gland when this is removed from the cow during processing (H.F. Troutt, personal observation). A number of foodborne pathogens, including Salmonella (10) and Staphylococcus aureus - a significant mastitis pathogen - can be transmitted through raw milk.

The surfaces of beef carcasses can be contaminated by a variety of bacteria, some of which are human pathogens, including: Salmonella (33, 41), Staphylococcus aureus (37, 41), Listeria monocytogenes, Campylobacter jejuni/coli, Clostridium perfringens and Escherichia coli O157:H7. The level of contamination likely depends on a number of variables, including the presence of pathogens in or on the animal at slaughter, the design of the processing facility (51), and hygiene and sanitation practices associated with processing (31, 37).

Of relevance here is whether or not cull dairy cows harbour foodborne pathogens at a greater prevalence than either fed beef cattle or cull beef cows; and if this is the case, it should be determined whether or not this implies that there is a greater risk of carcass contamination. The authors are unaware of data which fundamentally address these questions. Data obtained on a broad survey dealing with beef carcass microbiological contaminants (to establish baseline levels) were obtained from fed cattle (37). For the most part, dairy cattle in the USA are intensively raised and maintained, and many opportunities exist to acquire and maintain foodborne pathogens throughout the production cycles (66). It is of interest that a slightly higher prevalence of Salmonella was found (33) from brisket samples of cows and bulls than from steers and heifers.

Cull dairy cows have been incriminated as the source of Salmonella Newport-contaminated hamburgers causing foodborne illness (63). In the USA, a number of bacteria from livestock have been identified (77) as significant foodborne pathogens of livestock, including Campylobacter jejuni, Salmonella, Escherichia coli O157:H7 and Listeria monocytogenes. Due to the nature of the cull dairy cow, Staphylococcus aureus and Clostridium perfringens will be discussed as additional potential foodborne threats from dairy cow meat.

Salmonella

Salmonella are principal pathogens in foodborne disease outbreaks associated with the consumption of undercooked beef (2, 67), particularly ground beef (22, 24, 34, 63). S. Newport (22, 34) and S. Typhimurium (24) have been implicated. Salmonella are of major concern to the dairy industry because a variety of serovars was incriminated in outbreaks of human salmonellosis associated with the consumption of dairy foods (15). Between 1965 and 1981, fourteen outbreaks of human salmonellosis associated with the consumption of dairy products occurred, involving eight Salmonella serovars (15). Of these outbreaks, nine involved the consumption of raw or certified raw milk; S. Typhimurium and S. Dublin were the causative agents in four outbreaks each (15).

Salmonellosis is an important disease of dairy cattle and calves (50). In 1994-1995, the serotypes most frequently isolated from clinically affected cattle were: S. Typhimurium, including Copenhagen, S. Dublin, S. Kentucky, S.9,12:nonmotile, S. Montevideo, S. Muenster, S. Newport, S. Anatum and S. Cerro (18). Salmonella Typhimurium and S. Dublin are considered the primary serotypes isolated from cattle (18, 54). Salmonella serotypes can be shed in the milk of asymptomatically carrier dairy cows (28, 61) and can be recovered from the mammary gland at slaughter (28). These findings have significance in the slaughter of cull dairy cows. Inappropriate excision of the mammary gland at slaughter can lead to contamination of the carcass, personnel and environment with milk which could contain Salmonella (and/or other milk-borne pathogens).

Smith et al. revealed a Salmonella-positive farm prevalence of 11.7% (7760 dairies) by bacteriological culture of pooled faecal and environmental samples, but a 61% positive farm prevalence using serological sampling (62). These results prompted the conclusion that bacteriological culture of faeces and environmental specimens probably underestimates the prevalence of Salmonella-positive farms (62).

Salmonella can persist within dairy cows and the surrounding environment for several years without showing evidence of clinical disease or production inefficiency (25, 28). There is a possibility that during such periods, cows which may have been Salmonella carriers are routinely culled for slaughter. The stress of transport to slaughter facilities and withdrawal of feed can increase the prevalence of Salmonella infection in cattle (44, 72). Research has shown that moderately elevated rumen pH and decreased concentrations of total acidity, as
would occur in withholding of food, are conditions which foster growth of a variety of Salmonella serotypes in rumen fluid of cattle at slaughter (44). This growth of Salmonella can contribute to carcass and environmental contamination during processing. Using faecal swabs, Gay et al. found the rate of faecal shedding of Salmonella in 1,289 dairy cows marketed in the state of Washington to be approximately 0.5% (26). When mesenteric lymph nodes and rumen contents were cultured (57), a wide variety of serotypes of Salmonella were isolated with a high prevalence (76%) from a population of 100 culled cows. Samuel et al. speculated that mesenteric lymph nodes, especially from cattle held at slaughter for several days, must be considered as a source of contamination in slaughter facilities (57).

Recently there has been an increase in the incidence of Salmonella outbreaks in dairy cattle in the Pacific Northwest of the USA (3). Examination of the isolates from these outbreaks revealed that some were associated with the multiple antimicrobial resistant strain S. Typhimurium definitive type (DT) 104 (3). This is the first report (3) of S. Typhimurium DT104 in the USA. This organism has an antimicrobial resistance pattern to ampicillin, chloramphenicol, streptomycin, sulfonamides and tetracycline (R-type ACSSuT) and a plasmid profile characterised by the presence of a 6 megadalton plasmid (3). S. Typhimurium DT104 has been responsible for significant outbreaks of salmonellosis in cattle and humans in Great Britain (16, 74). Investigations in Great Britain strongly suggest that humans can contract S. Typhimurium DT104 by handling sick cows and calves (74). Besser et al. (3) examined S. Typhimurium isolates from human cases of salmonellosis in the Pacific Northwest and found that 4% (2/46) in 1989 were R-type ACSSuT compared to 42.5% of 188 isolates in 1994. At the time of the report, the investigators (3) typed 28 R-type ACSSuT S. Typhimurium isolates and found all to be DT104. Besser et al. (3) point out that because it is illegal in the USA to use chloramphenicol in food-producing animals, routine diagnostic antimicrobial testing may not detect R-type ACSSuT S. Typhimurium because chloramphenicol may not be included in the battery of antimicrobials used. The findings described in this report (3) portend a potentially serious public health/food safety problem.

In the USA, the initiation of sampling studies and surveillance programmes in all regions will be essential to ascertain the relative prevalence of Salmonella serotypes, including the identification of R-type ACSSuT S. Typhimurium in slaughter cattle, especially culled cattle.

Salmonella must be considered a serious foodborne risk from raw or undercooked ground beef. Meat from dairy cows (potential Salmonella carriers for a variety of epidemiological reasons), contaminated in a variety of ways during slaughter processing, contributes to this risk.

Campylobacter jejuni

As a cause of foodborne disease, Campylobacter jejuni does not trigger the same degree of concern as either E. coli O157:H7 or Salmonella. The organism rarely causes death or 'spectacular outbreaks of food poisoning' (45). Nevertheless, C. jejuni is one of the most common causes of bacterial enteritis in humans (23, 45). In the USA, the organism is one of the foodborne pathogens (along with Salmonella, E. coli O157:H7 and Listeria monocytogenes) targeted for reduction by the year 2000 (77).

Campylobacter jejuni, as a cause of foodborne illness, is often associated with consumption of contaminated poultry products (7, 23, 45). However, C. jejuni is an inhabitant of the gut of cattle (23) and carcasses may be contaminated by intestinal contents during slaughter (23, 41). C. jejuni has been recovered from heifer and steer carcasses (4% of 2,064 carcasses) in federally inspected slaughter facilities in the USA (41). A reasonable assumption is that the organism could be recovered with at least the same prevalence from the carcasses of culled dairy cows.

Raw beef has been suspected as the vehicle in a campylobacteriosis outbreak (20). However, Tokumaru et al. (65) were unable to detect Campylobacter in any of the 52 beef samples collected at slaughterhouses and meat shops. Owing to the drying conditions associated with mechanical ventilation and chilling in the slaughterhouse, Butzler and Oosterom (8) were of the opinion that beef carcasses leaving the slaughterhouse are unlikely to be a significant source of Campylobacter infection.

Escherichia coli O157:H7

In 1982, investigations of outbreaks of haemorrhagic colitis in humans linked E. coli O157:H7 to the consumption of undercooked ground beef (52). At that time, the organism was considered 'rare' (52). Subsequently, E. coli O157:H7 has been linked to healthy dairy cattle (9, 42, 76) and is now considered to be an emerging foodborne pathogen (73). Strains of E. coli O157:H7 produce potent cytotoxins on Vero cells and are designated verocytotoxin 1 and 2 (46, 59). The verocytotoxins then cause the major manifestations of E. coli infection: haemorrhagic colitis, haemolytic-uremic syndrome and/or thrombotic thrombocytopenic purpura (68). In 1990, additional research was advocated to ascertain whether verotoxin-producing E. coli were indeed foodborne zoonotic agents (75). Wells et al. demonstrated dairy cattle as a reservoir for E. coli O157:H7 (76), and Doyle summarised that E. coli O157:H7 outbreaks were associated with the consumption of undercooked ground beef and less often with raw milk, and that the organism could be found in ground beef from dairy cattle (14).
In 1993, an outbreak of *E. coli* O157:H7, involving some 400 cases, occurred in the Pacific Northwest. Subsequently, 125 patients were hospitalised and 4 children died (12). The outbreak was linked to the consumption of undercooked hamburger meat contaminated with *E. coli* O157:H7 (12). This outbreak provoked a dynamic and ongoing national examination of food safety priorities, policies and procedures in the USA.

The prevalence of *E. coli* O157:H7 in cattle populations is of major concern (68). Hancock et al. found a prevalence of less than 1% (0.28%) in over 3,500 faecal samples obtained from dairy animals of various ages in 8.3% (5/60) of herds tested (32). *E. coli* O157:H7 was isolated from 2 of 1,273 lactating and 1 of 477 non-lactating dairy cows (32). Within positive dairy herds, the organism was found in 1.7% (2/120) of lactating cows and 2.6% (1/39) of non-lactating cows. In the same study (32), *E. coli* O157:H7 was found in 0.71% of over 1,400 faecal samples from pastured beef cattle in 16% (4/25) of herds tested and in 0.33% of samples (2/600) from feedlot cattle. Hancock et al. were concerned that the study underestimated prevalence (32). However, Wells et al. also found a low prevalence (0.15%) of *E. coli* O157:H7 in adult dairy cows, although the prevalence was much greater (2.0% to 11.1%) in heifers and calves (76). Using a colony blot hybridisation technique, Cullor (11) was unable to detect verotoxin genes in *E. coli* isolates from field cases of mastitis, which suggests that the presence of verotoxigenic organisms in the mammary gland is of rare occurrence. Wells et al. reported isolating *E. coli* O157:H7 from two raw milk samples (76). The source of *E. coli* O157:H7 in raw milk was probably faecal or other contamination (68). Thus, both beef and dairy cattle appear to carry and shed *E. coli* O157:H7 at a relatively low prevalence (32). However, shedding from all cattle at slaughter may be exacerbated by both the stress of transport and withdrawal from food prior to slaughter (68).

**Listeria monocytogenes**

*Listeria monocytogenes* is a foodborne pathogen (2) which is widely distributed in nature and which can be isolated from a variety of sources, including cattle faeces, soil, vegetation and raw poultry and beef (13, 73). *L. monocytogenes* can be isolated from silages, especially poorly fermented silages (73) with an elevated pH (13). Silages are a major food ingredient of dairy cattle rations. The organism can be isolated from a variety of mammals and birds, including healthy cattle (13). In cattle, *L. monocytogenes* can produce clinical diseases including abortion and encephalitis and, rarely, mastitis (17). Ground beef and raw milk, among other meat and dairy products, have been listed (10) as vehicles for foodborne *L. monocytogenes* infections. In the USA, the first recognised outbreak of foodborne *L. monocytogenes* infection was associated with the consumption of pasteurised milk which came from dairy farms where listeriosis had occurred, and *L. monocytogenes* was subsequently isolated from raw milk samples from these farms (21). *L. monocytogenes* has been isolated from 12 of 292 (4.1%) bulk tank samples (56). The presence of the organism in raw milk seems to result from contamination from cattle faeces or the environment (56). However, Wesley et al. have demonstrated that dexamethasone administration to dairy cows, simulating the stress of transportation, increased the shedding of *L. monocytogenes* in milk of chronically infected dairy cows (78).

*L. monocytogenes* has been recovered from 4.0% of 2,064 beef heifer and steer carcasses (41) and is readily isolated from ground beef (81).

The meat from dairy cows following carcass contamination, from intestinal contents or the environment, seems likely to serve as a source of foodborne *L. monocytogenes* infection, especially through ground beef.

**Clostridium perfringens**

*Clostridium perfringens* is a foodborne pathogen which can be isolated at low levels from raw meat and is considered to be primarily associated with outbreaks involving food-handling problems (7). Genigeorgis (27) cited data from the United States Centers for Disease Control and Prevention demonstrating that between 1968 and 1973, beef accounted for 40.6% of *C. perfringens* food poisoning episodes, and 49% of these episodes were associated with eating in restaurants. Cattle carcasses can be contaminated with *C. perfringens* during the slaughter process (6). The organism has been isolated from 2.6% of 2,064 beef steer and heifer carcasses (41). *C. perfringens* is considered a usual inhabitant of the intestinal tract of cattle (80) and a prevalence rate of 80% has been found in the faeces of beef cattle (27). The organism may multiply in the intestine of cattle because of dietary components such as elevated protein (1). It is reasonable to assume that *C. perfringens* has a prevalence in dairy cattle similar to that found in beef cattle. The diets of dairy cattle (and fed beef cattle) in the USA very commonly contain silage. Approximately 72% of dairy farmers in the USA produce corn silage (39) and *C. perfringens* can be a significant component of the clostridial species in silage (49). Hence, as a consequence of contamination during slaughter, the carcasses of culled dairy cattle are as probable a source for *C. perfringens* as the carcasses of beef cattle.

**Staphylococcus aureus**

*Staphylococcus aureus* is a major cause of foodborne illness (2). Strains of *S. aureus* produce enterotoxins (SEs), known to be the emetic cause in staphylococcal food poisoning (43). Outbreaks of *S. aureus* food poisoning are frequently associated with improper food handling and temperature
'abuse of foods of animal origin, typically in homes or food service establishments following cooking' (7). The implication is that the sources of \( S. \text{aureus} \) food poisoning are essentially food handlers as well as improper food preparation and refrigeration (7, 43, 45).

Strains of \( S. \text{aureus} \) can become endemic in processing plants (45), and meat can become contaminated from human and animal sources (5). \( S. \text{aureus} \) has been recovered from 4.2% of 2,089 beef steer and heifer carcasses (41), and the organism is found in raw beef (10).

Milk from dairy cows with staphylococcal mastitis may be a source of the organism (43). \( S. \text{aureus} \) is a major and very costly cause of both clinical and subclinical mastitis in dairy cows (4). The infected mammary gland and mastitic milk can be considered major sources of the organism for transmission on dairy farms (4, 53). Intramammary infection due to coagulase-positive \( S. \text{aureus} \) can affect over 18% of multiparous dairy cows and 40% of dairy cows in herds with a high prevalence of cows with coagulase-positive \( S. \text{aureus} \) intramammary gland infection (53). Chronic staphylococcal mastitis is a major reason for culling dairy cows (79).

For \( S. \text{aureus} \) strains, there is a high correlation (93% to 100%) between coagulase production and the production of enterotoxins (43). According to Martin and Myers (43), there are at least seven heat-stable staphylococcal enterotoxins (SEs) associated with food poisoning: A, B, C, \( C_2 \), \( C_3 \), D and E. \( S. \text{aureus} \) strains isolated from dairy cows usually produce SEC or SED (36, 43), while isolates from humans produce SEA (43). Twenty-two of 157 (14%) \( S. \text{aureus} \) isolates from dairy cows with acute mastitis produced either SEC or SED (one isolate produced both) (48). Staphylococcal enterotoxin A, along with SEB, SEC and SED, were detected from \( S. \text{aureus} \) isolates cultured from the mammary glands of dairy cows in New York (36).

In slaughter plants, the cull dairy cow may be a source of \( S. \text{aureus} \) contamination of carcasses, implements and equipment, and workers. If infected mammary gland contents contaminate the hide and/or implements and workers because of leakage from teats or inappropriate incision when the udder is removed, carcass contamination with \( S. \text{aureus} \) can occur.

### Conclusion

The meat from cull dairy cows is a likely source of foodborne microbiological hazards. Special risks may be present for \( S. \text{aureus} \). In the USA, dairy cattle are raised and managed with increasing intensification, and this intensification may promote the maintenance of a variety of micro-organisms which could be pathogenic to humans through food. Furthermore, various channels through which these cattle pass en route to slaughter increase the risk of exposure to these foodborne pathogens. In the USA, increasing emphasis is being placed on hazard analysis and critical control point (HACCP) programmes within slaughter facilities to reduce the risk of carcass contamination and the eventual transmission of foodborne pathogens. To a degree, the viability of HACCP within slaughter facilities may be at least partially dependent on the pathogen load present at slaughter. An important step will be to conduct broad-based and widespread microbiological surveys of cull dairy cattle from farm to slaughter to ascertain the prevalence of foodborne pathogens associated with this important source of food. These studies should facilitate the development of good management strategies leading to the reduction of foodborne pathogens in cull dairy cows.

### Other possible microbiological hazards

The relationship of possible other microbiological foodborne hazards, including \( Y. \text{enterocolitica}, A. \text{hydrophila} \), and \( B. \text{cereus} \) to meat from dairy cows is difficult to assess. \( Y. \text{enterocolitica} \) has caused foodborne illness through raw milk (10). \( A. \text{hydrophila} \) are associated with human gastroenteritis, and foods of animal origin may be a source (47, 60). \( A. \text{hydrophila} \) spp., primarily \( A. \text{hydrophila} \), have been readily isolated from commercially obtained ground beef (47, 60). However, \( A. \text{hydrophila} \) spp. were found in relatively low numbers in faeces from six- to nine-month-old cattle (64). The source of \( A. \text{hydrophila} \) spp. in the ground beef is possibly water (64). \( B. \text{cereus} \) is a ubiquitous organism which has been found in raw beef and raw milk (10). The organism can have direct links to dairy cows: \( B. \text{cereus} \) has been incriminated in both abortion (58) and mastitis (53) in dairy cattle. Thus, the contamination of carcasses by \( B. \text{cereus} \) is possible at the time of slaughter of cull dairy cows.
Viande de vaches laitières :
les dangers et risques microbiologiques éventuels

H.F. Troutt & B.I. Osburn

Résumé
Les auteurs donnent un aperçu sur les conditions de réforme des vaches laitières aux États-Unis d'Amérique et mettent l'accent sur d'importants risques microbiologiques éventuels liés à la viande des vaches de réforme. Dans ce pays, les vaches de réforme, dont on tire au moins 17 % environ de la viande hachée produite annuellement, constituent une importante ressource alimentaire. Les risques microbiologiques potentiels de toxi-infections alimentaires associés à la viande de vaches de réforme, examinés ici, comprennent : Salmonella (et notamment S. Typhimurium DT104), Escherichia coli O157:H7, Campylobacter jejuni, Listeria monocytogenes, Clostridium perfringens et Staphylococcus aureus. Les auteurs indiquent les sources et les voies de contamination ainsi que les risques potentiels de transmission alimentaire de Bacillus cereus et Aeromonas spp. En conclusion, de plus amples études microbiologiques s'imposent pour déterminer le taux de présence de ces différents micro-organismes dans la viande des vaches de réforme et les risques de toxi-infections alimentaires qui leur sont associés.

Mots-clés

La carne del ganado lechero:
posibles peligros y riesgos microbiológicos

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Resumen
Los autores examinan el conjunto de circunstancias que acompañan el sacrificio del ganado lechero en Estados Unidos de América, centrándose en los posibles riesgos microbiológicos significativos asociados a la carne de vacas lecheras descartadas. Habida cuenta de que su carne representa por lo menos el 17% del picadillo que se consume en Estados Unidos de América, dichos animales constituyen una importante fuente de alimento en este país. Se contemplan aquí los siguientes riesgos microbiológicos de intoxicaciones alimentarias asociadas a la carne de vacas lecheras eliminadas: Salmonella (con especial atención a S. Typhimurium DT104), Escherichia coli O157:H7, Campylobacter jejuni, Listeria monocytogenes, Clostridium perfringens y Staphylococcus aureus. Se evocan las posibles fuentes y vías de contaminiación, así como el riesgo potencial de intoxicación alimentaria por Bacillus cereus y Aeromonas spp. A modo de conclusión se señala la necesidad de realizar amplios estudios microbiológicos que permitan determinar la prevalencia y el riesgo de microorganismos responsables de intoxicaciones alimentarias en la carne de ganado lechero descartado.

Palabras clave
References


