Risks and prevention of contamination of dairy products

J.S. Cullor

Dairy Food Safety Laboratory, Veterinary Medicine Teaching and Research Center, 18830 Road 112, Tulare, California 93274, United States of America

Summary
Consumers and regulatory officials are becoming increasingly aware of the human health risk of the presence of micro-organisms or chemicals in the agricultural environment. Providing 'on-farm food safety' programmes which address the daily management of the production unit with regard to animal health and well-being, public health and environmental health must be a top priority for agriculturists and veterinarians. Developing critical control point management (CCPM) procedures for animal and human health concerns is a viable approach to aid in alleviating public concerns about dairy products and the food supply in general. Such CCPM programmes may be created for individual production units based upon risk analysis, total quality management and hazard analysis and critical control point principles. Implementation of these programmes will be essential both in addressing food safety concerns for the resident population of a nation and in developing or maintaining international markets for the export of animal products.

Keywords

Introduction
The Council for Agricultural Science and Technology (CAST) task force has published data demonstrating that foodborne illness affects between 6.5 and 33 million people each year in the United States of America (USA), with approximately 9,000 deaths annually (8). Each time an outbreak of foodborne illness occurs, regulatory officials want to 'trace back' from the outbreak to the place of origin of the pathogen, and the farm is frequently incriminated as the source of the problem. As a result of this pressure, the call for on-farm pathogen reduction programmes is emphasised in Recommendation No. 14 of the task force report which recommends that control practices be applied from food source to consumption, including the incorporation of hazard analysis and critical control points (HACCP: pronounced "hassip") principles. New scientific advances should be incorporated into control practices' (8).

Consumers who become more aware of public health issues regarding food and water supplies often respond by demanding more intervention in food production processes on behalf of safety concerns. Important sources of some food-poisoning organisms and water-borne human pathogens are presented in Table I. The risks and consequences of

Table I
Sources of selected food-poisoning organisms and water-borne pathogens

<table>
<thead>
<tr>
<th>Organism</th>
<th>Food source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella</td>
<td>Raw or undercooked meat, poultry, milk, eggs, fish, shellfish, pork, ice-cream</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>Raw or undercooked meat, poultry, pork, lamb, cheese, raw milk, apple cider, green salads</td>
</tr>
<tr>
<td>Campylobacter jejuni</td>
<td>Raw or undercooked poultry, pork, lamb, turkey, beef, raw or inadequately pasteurised milk, untreated water, fresh mushrooms</td>
</tr>
<tr>
<td>Listeria monocytogenes</td>
<td>Seafood, raw or undercooked red meats, pork, poultry, turkey, fermented sausages, vegetables, ice-cream, eggs</td>
</tr>
<tr>
<td>Cryptosporidium</td>
<td>Water</td>
</tr>
</tbody>
</table>
foodborne and water-borne pathogens are becoming major issues for the public which is requesting the immediate implementation of on-farm controls. In response to this pressure, the United States Congress introduced the 1994 Pathogen Reduction Act. In addition, the Food and Drug Administration (FDA) invited comments on a published proposal entitled: ‘Food safety assurance program; development of hazard analysis and critical control points; proposed rule’, which requires the retail food and food processing industries in the USA to apply HACCP principles to production procedures commencing in 1997 (17).

To apply HACCP principles correctly, scientists and regulatory officials will need to implement risk analysis procedures. These procedures will form the basis for an assurance that consistent scientific methodologies for risk assessment will be employed on a world-wide basis. Risk analysis procedures are served well by defining the perceived or real hazard (i.e., a biological, chemical or physical agent or a property of the agent which may have an adverse health effect), then defining the risk as a function of the probability of an adverse effect on public health. Risk analysis then becomes a process consisting of three components, as follows:

a) risk assessment
b) risk management
c) risk communication.

Risk assessment is the scientific evaluation of known or potential adverse health effects resulting from human exposure to foodborne hazards. Thus, hazard identification and hazard characterisation must be described to the fullest extent possible.

Risk management is the process of weighing policy alternatives to accept, minimise or reduce assessed risks.

Risk communication must follow as an interactive process of exchanging information and opinion on risk among risk assessors, risk managers and all other interested parties.

The HACCP principles will require processing plants to examine unprocessed products (i.e., milk or cull cows) for potential human pathogens. If any of these harmful organisms are detected, the plant personnel will be forced to perform trace-back procedures which will indicate the dairy farm of origin. Thus, veterinarians and dairy producers will soon be obliged to adopt a new standard of ‘good dairy practices’ or ‘critical control point management procedures’ which identify critical control points both for organisms which cause animal diseases and those organisms on the dairy farm which may be of concern to public health officials. Therefore, calls for the implementation of ‘HACCP-based’ programmes on the farm or production unit will necessitate the accumulation of additional scientific information.

Target organisms: CDC Healthy People 2000

In 1991, the Centers for Disease Control and Prevention (CDC) published a report entitled Healthy People 2000 (36). This report states the health status objectives for the following specific target organisms: Salmonella species, Campylobacter jejuni, Listeria monocytogenes and Escherichia coli O157:H7. This paper provides a brief discussion of these organisms, their potential impact on human health and potential sources on the dairy farm and is adapted from an earlier article published for veterinarians (9).

Escherichia coli O157:H7

Escherichia coli is a member of the normal flora of the intestinal tract, but some strains are pathogenic and cause diarrhoea and other symptoms by a number of different toxins. Infection with verotoxin-producing strains of Escherichia coli (VTEC) in humans can cause symptoms ranging from diarrhoea, bloody stools, haemolytic uremic syndrome, to death from renal failure (24, 39). A recent outbreak (autumn 1996) of illness and death due to the E. coli O157:H7 organism occurred in connection with contaminated apple juice. Regulatory officials are suggesting that faeces from deer or dairy cattle contaminated the apples prior to processing.

Escherichia coli O157:H and farm animals

Scientists employed specific gene probes to examine 2,100 E. coli strains from the faeces of healthy animals. Of the samples, 10 out of 82 milk cows, 20 out of 212 beef cattle and 5 out of 75 pigs were reported to carry genes for the toxins. Several of the serotyped isolates have been described to be pathogenic for humans (O157:H7, O82:H8, O116, O113, O126, O91, etc.) (23).

In one part of the National Dairy Heifer Evaluation Project conducted by the Veterinary Services of the United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), 6,894 heifer calves from 1,068 dairy herds were sampled in 28 States. The study reported a prevalence of 3.6/1,000 for the isolation of E. coli O157:H7 from the calves. Calves from two weeks to less than twelve weeks of age demonstrated the presence of E. coli O157:H7; however, no culture-positive faecal samples were revealed among 653 calves sampled during the first week of life. Culture-positive calves were present in all regions of the USA, and the herd prevalence was estimated to approach 5% (20). No information concerning the capability of these isolates to produce verotoxins was reported.

A study presented at the 14th Annual Western Food Animal Disease Research Conference in Moscow, Idaho, estimated the herd prevalence of E. coli O157:H7 in the State of Washington. The organism was isolated from 10 of 3,750
faecal samples (0.28%). This represented 5 of the 60 dairy herds examined (8.3%). Post-weaning heifers showed a higher prevalence than other age groups. Current technology, faecal slurry, bulk tank milk and milk filters were reported to give unreliable samples for screening the status of a herd with a higher prevalence than other age groups. Current technology, when the colony blot hybridisation technique was used, 16 probes. Of these isolates, ten were not *E. coli*. However, when the sixteen isolates were examined after chromosomal DNA extraction and vacuum blot hybridisation, none revealed positive results for one or both of the verotoxigen probes. Of these isolates, ten were not *E. coli*. However, when the sixteen isolates were examined after chromosomal DNA extraction and vacuum blot hybridisation, none revealed positive evidence for the VT-1 or VT-2 genes (J.S. Cullor, unpublished data).

**Listeria monocytogenes**

*Listeria monocytogenes* is an organism which can be harboured by a variety of animals, including domestic and wild mammals, fish, avian species, amphibians and insects (6). In humans and animals, amnionitis caused by *Listeria* may result in abortion, stillbirth or neonatal sepsis. Maternal infection is characteristically asymptomatic or mild, but the foetal infection is severe. The rate of human mortality from listeriosis remains of concern to public health officials.

Listeriosis is usually fatal for sheep and pigs, but cattle may recover with signs of injury to the nervous system. The most common clinical manifestations of animal listeriosis are encephalitis, septicaemia and abortion. The clinical signs of listeriosis in ruminants begin with fever which may disappear after several days, dullness and anorexia, which are followed by the development of nervous symptoms after two to three days. Inco-ordination appears soon after the nervous involvement, and the animal develops a tendency to turn in circles, in the same direction ('circling disease'). Degenerative changes occur in the central nervous system (CNS), progressing to muscle paralysis. Several of the following neurological signs may develop in cattle: dropped jaw, unilateral facial paresis or palsy (resulting in keratitis), depressed ear, eyelid spasticity, medial ataxia, circling and head tilt towards the affected side, ataxia of all limbs or recumbency, head tremor, inability to eat and drink, vomiting of ruminal ingesta, mild to severe depression, dehydration and fever. In cattle, differential diagnosis with special attention to bovine spongiform encephalopathy, rabies, middle ear infections, polioencephalomalacia and thromboembolic meningoencephalitis should be considered for evaluation.

*Listeria monocytogenes* can cause mastitis in cows, and can be shed in the milk from all four quarters of the udders of carrier cows for at least seven months (10, 15, 37). This organism has also been reported to be excreted in milk from asymptomatic cows and goats (26) and in faeces, respiratory tract mucus, vaginal mucus and milk of clinically normal sheep (32).

*Listeria monocytogenes* is more likely to contaminate the environment through faeces, urine or secretions such as conjunctival, oral, nasal and uterine fluids of carriers (32). Wild birds and silage have been reported to harbour *Listeria* (13); roof rats have also been shown to harbour *L. monocytogenes* and can contaminate their own environment. Although *L. monocytogenes* can invade the body by the ocular, cutaneous, respiratory or urogenital route, the oral route is now believed to be the major port of entrance for human listeriosis. The mechanical spreading of manure containing *Listeria* can contaminate vegetables and may, therefore, result in the transmission of this pathogen to man.

The occurrence of listeriosis can be either sporadic or epidemic. The sporadic form of the disease is characterised by isolated cases and the epidemic form is characterised by a cluster of cases with a common, usually foodborne, source of infection. Listeriosis in ruminants has often been associated with contaminated silage (5, 14, 18, 19, 27). The pH of the silage seems to be an important factor for the presence of *Listeria*, and the growth of the organism has been shown to be influenced by the pH in media made of grass silage (22). Growth increased in the alkaline pH, and a pH value was demonstrated to be the critical point: above this value, *Listeria* was able to multiply, and below that level, the viability of the organisms could not be sustained. However, this pathogen has also been found in a good quality silage with a pH of 4.0, although at lower frequencies (19).

**Salmonella**

Salmonella infections in humans and animals cause a variety of disease manifestations, such as typhoid fever, enteric fevers, food poisoning, septicaemia, localised abscesses and inflammatory foci in almost any organ of the body, and a chronic carrier state. These infections are acquired by ingestion of contaminated food or water. Salmonella are capable of invading intestinal mucosal cells and can produce endotoxins.

The two Salmonella serotypes most frequently isolated from cattle are *Salmonella Typhimurium* and *S. Dublin*. *S. Dublin* infections in humans have been linked to the consumption of
jejuni infection due to animal A comprehensive review of C. S. Dublin is an invasive pathogen which causes septicaemia with high morbidity and mortality in calves, while the most common clinical manifestation in adult cattle is severe diarrhoea and abortion. Animals which recover from acute infections shed the organism in faeces for between four and six weeks after the clinical event. A small percentage of infected animals recover clinically, but maintain chronic mammary gland and/or intestinal infections without overt clinical signs of the disease. Carrier animals may shed billions of S. Dublin organisms per day in faeces and milk for years, presenting a substantial challenge for susceptible hosts and environmental concerns (34). By employing a combination of routine serum antibody testing and bacterial culture of milk and faeces from suspect animals, persistently infected cattle and food sources has been written by Altekruse (1). This disease can result in deaths on rare occasions. Infection with Campylobacter spp. occurs by ingestion of contaminated milk, poultry, barbecued sausage or water. Sporadic infections in man may be derived from animals: for instance, domestic dogs can be asymptomatic carriers of Campylobacter. Other reservoirs of this organism include wild birds, cats, ferrets (Mustelidae), hamsters (Cricetus spp.), bears (Ursus spp.) and mule deer (Odocoileus hemionus). Housells may become vectors for C. jejuni (4).

Campylobacter jejuni is an intestinal pathogen which causes diarrhoea and abortion in many species of farm animals. Experimental infections with the organism in calves result in clinical manifestations which range from ileitis to colitis, with mild diarrhoea containing blood and mucus. Possible control points in dairy production may include sanitation, water treatment and elimination of vectors (1).

Cryptosporidium

Cryptosporidium are capable of infecting most domestic animals as well as man (4). Cryptosporidiosis is a protozoal disease which is considered a major pathogen of calves aged from one to four weeks. The parasite invades the enterocytes of the distal small intestine and the large intestine. The organism causes profuse watery diarrhoea, which may last from days to months, as a result of villous atrophy leading to maladsorption and secondary milk fermentation. Oocyst secretion coincides with the onset of diarrheoa and usually persists for a few days after the end of the diarrheic phase. Diarrhoea is often accompanied by abdominal pain, nausea, vomiting, malaise and fever.

Faecal specimens from 200 stray dogs impounded at the San Bernardino City and County animal shelters and stool specimens from 664 people were submitted to the San Bernardino County Department of Public Health Laboratory for routine parasitological examination including screening for Cryptosporidium spp. A total of 4 out of 200 (2%) dogs were reported to be passing cryptosporidial oocysts in faeces. Cryptosporidial oocysts were detected in 20 out of 664 human faecal specimens (3.01%) (11).

Recent epidemiological studies in Tokyo, Japan, and Glasgow, Scotland, indicate that cats were found to harbour Cryptosporidium oocysts. Both studies concluded that kittens and young cats were more likely to shed the oocysts, and that there was no difference in prevalence between domestic and feral cats. Arai et al. reported that of a total of 608 cats, 23 (3.8%) were found to have Cryptosporidium oocysts although no apparent clinical symptoms, such as diarrhoea, were detected (2). The clinical and post-mortem survey of domestic and feral cats in the Glasgow area by Mtambo et al. revealed that 19 of 235 (8.1%) cats were infected with Cryptosporidium spp. (31). Two of the seven domestic cats with Cryptosporidium infection also showed the presence of feline immuno-deficiency virus.

Outbreaks of gastrointestinal illness due to contaminated municipal water supplies have been associated with Cryptosporidium spp. (30, 38). A noteworthy occurrence in April 1993 caused prolonged diarrhoeal illness in over 400,000 Milwaukee, Wisconsin, residents with approximately 4,400 patients requiring hospitalisation (28). Although not documented, the alleged source of the pathogen was considered to be run-off water from local dairies.

Miron et al. performed an epidemiological study which associated calves with an outbreak of diarrhoea due to Cryptosporidium in children in Israel (29). The initial case of diarrhoea in the index parent occurred during an outbreak of cryptosporidial diarrhoea in calves housed in a kibbutz and just 10 days before diarrhoea caused by Cryptosporidium was reported in 14 of a total of 56 children. The outbreak in the children living in a kibbutz near the dairy farm was due to an initial animal to human transmission and continued with extensive human to human transmission.

Reducing the availability of this intestinal pathogen through learning how to manage the environment and ecosystem on the livestock production unit is a practical approach which may be useful in implementing control measures (3). For instance, mandatory cleaning and disinfection of facilities after each batch of calves play an important role in reducing contamination of the environment of the calf. Both ammonia
and formaldehyde are disinfectants which can be moderately effective against cryptosporidia, although these disinfectants are inactivated by organic matter. Caution must be exercised because formaldehyde is a highly toxic compound which requires a long contact time to be effective against this pathogen. Medical strategies to detect and eliminate carrier animals must be developed and scientifically evaluated for implementation on the production unit.

**Staphylococcus aureus**

The growth of *Staphylococcus aureus* and the production of enterotoxin is associated with foodborne illness in humans. The illness is characterised by a rapid onset of the disease (2-4 hours) and symptoms of nausea, vomiting, retching, diarrhoea, headache, cramps, sweating and prostration. Historical sources of the bacteria have been raw milk, animals, humans, air, water, sewage and articles which have come into contact with the aforementioned. Dairy foods which have been associated with *Staphylococcus aureus* food poisoning include non-fat dry milk, butter, cheese, chocolate milk, fermented milk and cream-filled pastries. Methods of control during food processing procedures include refrigerated storage of raw milk or raw cream (so that staphylococci cannot grow and produce the enterotoxin), proper pasteurisation, prevention of post-pasteurisation contamination and the use of active lactic cultures for the production of fermented products.

This organism is a common mastitis pathogen world-wide. The main source of infection is the milk secreted by adult cows with infected udder quarters. Contaminated milking equipment and the hands of milkers are common sources of transmission. Staphylococci have also been cultured from the skin of the udder, the teats and other parts of the body. Introduction of mastitis-causing *Staphylococcus* spp. into non-infected herds generally occurs through the acquisition of infected animals or handling by attendants who have had prior contact with infected cows. Infection generally results in subclinical mastitis in one or more quarters, with severe mastitis developing only occasionally.

**Clinical symptoms in cattle**

Most *Staphylococcus aureus* infections are chronic subclinical infections with occasional clinical flare-ups (usually mild or moderate), often at parturition, which revert to a subclinical state. *Staphylococcus aureus* can also produce severe mastitis with systemic signs of illness, particularly at parturition or during the first month of lactation. Systemic symptoms include anorexia, depression, toxæmia, elevated body temperature and recumbency. Swelling, firmness, subcutaneous oedema, redness, heat and painfulness may extend along the mammary vein. Alterations in the appearance of the mammary secretions begin with the presence of flakes and clots. These will increase in degree and the secretion can become creamy or pus-like as the disease progresses, at which point the secretion may become watery.

In a few cases of *Staphylococcus aureus* infection, particularly those which occur in the immediate postpartum period, a gangrenous mastitis may occur due to the staphylococcal alpha toxin. This form of the disease is reported in sheep and goats also. Vasocostriction, ischaemia and death of the tissue occurs. The quarter becomes markedly swollen, followed within hours to days by cold areas, and the teat and adjacent areas of the udder become blue or black. While arterial flow remains intact, thrombosis of large veins generally leads to a moist gangrene with continuous dripping of blood-tinged serum from the teat and the skin around the base of the teat. Amputation of the affected teat will facilitate drainage and sloughing. While mortality can often be prevented by aggressive treatment, the cow loses weight and production in the unaffected quarters is minimal. In most cases, convalescence is protracted and sloughing of tissue occurs for many weeks. Subsequent lactations with two or three functional quarters may result in partial recovery of milk production. Recovered cows are often sold for slaughter.

**Prevention and control in dairy cattle**

*Staphylococcal* mastitis must be considered a herd problem. Ignoring the infection will damage the productive capacity of the herd. Although intramammary dry cow therapy (treatment of the affected quarter through the streak canal during the sixty-day period before the new lactation begins) offers improved rates of recovery, the high incidence of treatment failures prevents this procedure from forming the basis for an effective control programme. Dry cow therapy is also useful in reducing the incidence of new infections. *Staphylococcal* mastitis is a contagious disease which is spread from cow to cow during milking. Although skin or fomites may harbour the organism, milk from an infected cow must be considered the principal source of new infections. Control measures will logically target the transmission from diseased to non-infected cattle in the milking parlour or barn. Effective procedures can be broadly categorised as either sanitation or segregation.

Commonly used sanitation procedures include the use of single service paper towels and the cleaning of the hands of milkers and milking units with germicidal solutions between cows. Automatic backflush equipment is an integral component of many newer milking facilities. Properly functioning milking equipment will minimise the reverse flow of potentially contaminated milk and reduce trauma to the teat end. A thorough analysis of milking machine performance, including vacuum levels, vacuum reserve, pulsation rates and pulsation ratios must be considered an integral part of any mastitis control programme. The use of germicidal teat dip solutions immediately after milking reduces the potential for skin or teat canal contamination to progress to intramammary infection.
The physical separation of infected and non-infected cattle eliminates the source and spread of infection from diseased cows and results in a decrease in the rate of new infections. Such isolation procedures can be accomplished either by culling infected cattle or by segregating the herd into culture-positive and culture-negative management groups following culture of composite milk samples from all cows, or by some combination of the two strategies. The decision will be influenced by the prevalence of infection, availability of replacements, physical facilities and the level of management expertise. At present, both these methods and the use of improved milking hygiene are seen as effective approaches. Infected cows are often segregated from the healthy cows and are then culled, as their economic value dictates. Infected cows are always milked after healthy cows.

The testing of milk samples from each quarter drawn from selected portions of the herd on a schedule which includes all lactating cows once every six weeks should be considered. Many variations of sampling schedules can be arranged to suit the situation. All clinical cases of mastitis, all purchased cows and all fresh cows (cows which have produced a calf within the last seven days) and heifers should be cultured on a routine basis. Cows with one or more quarters exhibiting scarring, fibrosis and decreased milk production should be dried off when no longer profitable, and then culled. Dry-cow therapy of infected cattle with currently available agents will be of limited value in eliminating chronic staphylococcus infection but should be followed in all cows because the procedure is useful in eliminating Staphylococcus agalactiae and in preventing other new Staphylococcus aureus infections.

Risk management

The two major products which leave the dairy and are destined for the food chain are raw milk and milk dairy cows. A number of pathogenic micro-organisms are transmissible to man through unpasteurised milk, i.e., Salmonella, pathogenic E. coli, L. monocytogenes, C. jejuni, Yersinia enterocolitica and S. aureus. However, the 1981 Symposium on Bacteriological Quality of Raw Milk held by the International Dairy Federation in Kiel, Germany, concluded that no authentic outbreak of disease can be attributed to pasteurised milk if:

a) the milk is adequately cooled before pasteurisation to prevent the development of heat-resistant microbial toxins
b) the pasteurisation equipment functions properly
c) post-pasteurisation contamination is prevented.

These conclusions remain accurate today.

The cull dairy cow represents a farm commodity which can potentially enter the food chain as meat. The primary bacteria of concern to the FDA and the USDA Food Safety and Inspection Service (FSIS) are Salmonella and E. coli. There are no known methods for producing live animals which are free of these pathogens when they leave the farm. Therefore, critical controls in the processing plant are necessary. Research around the world is being directed towards minimising or eliminating carcass contamination in the slaughter plant. A brief list of methods currently being tested include the following:

a) trimming and washing carcasses with hot water (74°C-87.8°C), then rinsing with ozone (0.3-2.3 ppm) or hydrogen peroxide (5%)
b) application of organic acids on the carcass (fumaric, acetic or lactic acid) in combination with various temperature controls
c) flash steam heating followed by evaporative cooling
d) studies involving gamma irradiation as a means to eliminate bacterial contamination
e) application of antimicrobial peptides to the surface of the carcass.

Discussion

In an excellent report regarding foodborne illness, Bryan examined food handling and reported on the risks of practices, procedures and processes which led to outbreaks of foodborne illnesses (7). The data set consisted of information gathered between 1961 and 1982. The paper reports that most outbreaks of foodborne illness due to food handling could be attributed to inadequate cooling; either leaving foods at room temperature or warm outside temperatures, or storing foods in large containers during refrigeration. The most frequently identified factors which contributed to some specific pathogen outbreaks were: improper cooling, contaminated raw products, inadequate heating, colonised persons handling cooked foods, a lapse of twelve or more hours between preparing and eating the food, and improper heating, reheating or hot-holding of the food. A similar set of contributing factors for foodborne outbreaks associated with processing plants was described, i.e., contaminated raw product, inadequate heat processing, colonised persons handling the implicated foods and improper cleaning of the equipment (7).

The safety of the world food supply is a pressing issue for governments, consumers, food retailers and processors. This sense of urgency must be recognised by dairy producers and veterinarians. Food safety begins on the dairy farm. Although the burden of microbial foodborne disease is not known with a high degree of certainty, the estimated annual number of clinical cases and deaths in the USA is somewhat disturbing, although the USA is among the leaders in providing a safe food supply (Table II) (33). In the USA, public health officials and regulatory agencies want to reduce or eliminate foodborne and water-borne illness by 'stopping the problem
Table II
Estimated annual foodborne cases and deaths in the United States of America, 1992

<table>
<thead>
<tr>
<th>Organism</th>
<th>Cases</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella</td>
<td>1,920,000</td>
<td>960-1,520</td>
</tr>
<tr>
<td>Campylobacter jejuni or Escherichia coli</td>
<td>2,100,000</td>
<td>120-360</td>
</tr>
<tr>
<td>Escherichia coli O157:H7</td>
<td>7,668-20,448</td>
<td>146-389</td>
</tr>
<tr>
<td>Listeria monocytogenes</td>
<td>1,526-1,581</td>
<td>378-433</td>
</tr>
</tbody>
</table>

Adapted from T. Roberts and L. Linnewehr [33]

Eradication of major foodborne pathogens, including E. coli O157:H7, from the livestock production unit seems very unlikely.

Until critical control points are known for zoonotic diseases, the dairy industry can adapt and implement good dairy practices (GDP) to aid in managing animal health problems and to begin addressing the problem of pathogens of concern for foodborne and water-borne illness. The establishment of on-farm procedures to monitor for the presence of emerging and re-emerging human pathogens, such as those mentioned in this paper, will soon be advisable. Probable on-farm critical control points for many of these human pathogens will include:

- housing and bedding
- water and waste management areas
- hospital pens, calving pens, treatment areas
- bulk tank milk
- young stock and cull animals

If a national standard of GDPs for the production of milk and dairy beef is adopted, documentation and education will alleviate many worries surrounding potential chemical and microbial residues leaving the production unit.

The available pool of highly susceptible people at risk for foodborne and waterborne illness is growing world-wide, as a result of medical technologies which increase the longevity of human patients with chronic and immuno-suppressive illness and the ageing population. Consumers now appear willing to place more emphasis on addressing both the acute and potential chronic effects of chemical and microbial contaminants in the food supply. As the world population grows further and further away from understanding production agriculture, producers and veterinarians must address the anxieties surrounding public health issues.

Table III
Criteria necessary for the eradication of a pathogen

<table>
<thead>
<tr>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>A single host species with no external reservoir</td>
</tr>
<tr>
<td>Species present on only a small percentage of farms, ranches, feedlots, etc.</td>
</tr>
<tr>
<td>The pathogen of interest serves as a disease marker for detecting endemic herds or flocks</td>
</tr>
<tr>
<td>Validation of appropriate assays which can correctly identify carrier animals</td>
</tr>
<tr>
<td>Establishment of an effective means of intervening in the chain of infection after carrier animals have been removed from the herd</td>
</tr>
<tr>
<td>Substantial financing (many billions of US dollars)</td>
</tr>
<tr>
<td>Long-term resolve by all involved to fully implement all measures necessary for eradication</td>
</tr>
</tbody>
</table>
Training must be provided now and for the future generations of animal agriculturalists in the development of working relationships to solve the concerns of government and consumers surrounding on-farm (pre-harvest) food safety issues.

Acknowledgements
The University of California Davis School of Veterinary Medicine is a Charter Member of the Food Animal Production Medicine Consortium. The author would like to thank the University of California Davis Livestock Disease Research Laboratory and the California Dairy Food Research Center for generous support of the Dairy Food Safety Laboratory.

Contamination des produits laitiers : risques et prévention
J.S. Cullor

Résumé
Les consommateurs et les pouvoirs publics sont de plus en plus conscients des risques que la présence de micro-organismes ou de résidus chimiques dans l'environnement agricole peut faire courir à la santé publique. C'est pourquoi des programmes de sécurité alimentaire doivent mettre en œuvre, dans l'élevage même, le suivi quotidien de chaque unité de production. Cela permettra d'y garantir la santé et le bien-être des animaux ainsi que la santé publique et la sauvegarde de l'environnement, qui doivent constituer une priorité absolue pour les vétérinaires et les responsables agricoles. La gestion des points de contrôle critiques pour la santé animale et publique est une méthode efficace qui devrait répondre aux préoccupations du consommateur en matière de sécurité alimentaire, notamment pour les produits laitiers. Ces programmes peuvent être appliqués dans les unités individuelles de production, en se fondant sur l'analyse des risques, la gestion de qualité globale et les principes des points critiques pour la maîtrise des risques. L'application de ces programmes doit garantir à la fois la sécurité alimentaire à l'intérieur du pays et la pérennité des échanges internationaux de produits d'origine animale.

Mots-clés

Contaminación de productos lácteos: riesgos y prevención
J.S. Cullor

Resumen
Los consumidores y las autoridades encargadas de la reglamentación son cada vez más conscientes de los riesgos que los microorganismos y residuos químicos en el entorno agrícola representan para la salud pública. La implementación de programas de protección alimentaria a nivel de la granja, que prevén el manejo cotidiano de cada unidad de producción para garantizar la sanidad y el bienestar de los animales y la salud pública y medioambiental, debe ser el primer objetivo de los productores y veterinarios. El desarrollo de sistemas de manejo de puntos
críticos en sanidad animal y salud pública es un método eficaz para responder a la preocupación de los consumidores relativa a la producción de alimentos. Estos programas pueden ser creados en cada unidad individual de producción, y fundarse en el análisis de riesgos, el manejo de calidad total y los principios de los puntos críticos de control. La implementación de estos programas es fundamental para la protección alimentaria a nivel del país productor y para el fomento de los intercambios internacionales de productos de origen animal.

Palabras clave

References


