Risks and prevention of contamination of beef carcasses during the slaughter process in the United States of America

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Summary
A brief general description of the beef cattle slaughter process used in the United States of America is presented. Considerable variation in prevalence of microbial contamination at beef processing establishments has been reported. Primary factors which may explain this variation include:

a) pathogen load on, or in, live animals entering the establishment
b) sanitation practices used by the establishment.

Pathogen load on, or in, live animals depends on environmental exposure to contaminants, the health of the animal, and on situations stressful to the animal which may increase microbial shedding, such as disrupted access to feed and water, transport, handling and contact with other animals. Processing stations and slaughter practices which are potential sources of carcass contamination are listed, and points on carcasses where contamination is most likely to occur are noted. Contamination risk-reduction measures within an establishment include carcass treatments with anti-microbial agents, trimming, washing, steaming, chilling and gamma irradiation.

Several good sanitation practices are described. Microbial monitoring is a necessary step for determining whether sanitation practices are efficacious, but the usefulness of microbial monitoring depends on the microbial tests selected, sampling procedures, frequency of sampling, the rapidity of receiving test results and consistent and accurate record-keeping and analysis. Federal inspection to ensure that processing establishments comply with new Federal regulations regarding the implementation of standard sanitation procedures and microbial testing should result in greater vigilance of good sanitation practices by establishments.

Keywords
Abattoirs — Beef cattle — Carcasses — Food safety — Food Safety and Inspection Service — Hazard analysis and critical control points — Microbial contamination — Public health — Sanitation — Slaughter — United States of America.

Introduction

Human morbidity in the United States of America (USA) attributable to meat- and poultry-borne pathogens may be as high as five million cases annually, and perhaps 4,000 of these cases end in death (16).

The tragic outbreak, in January 1993 in the State of Washington, of haemolytic uremic syndrome caused by Escherichia coli O157:H7 from consumption of undercooked ground beef stimulated efforts to reduce risk to consumers of exposure to foodborne pathogens. Although cooking meat at a sufficiently high temperature for a long enough duration kills most enteric bacteria, cooking should not be the only...
means used to reduce public health risks. Lowering pathogen load at all stages along the production chain should be the goal for food safety regulators.

This paper focuses on the risks and prevention of bacterial contamination which may occur at the abattoir. The scope of this review is limited to the slaughter of beef cattle and presents only the risks and risk reduction measures which may occur between the arrival of the animal at the abattoir and the entry of the carcass into the chilling room (cooler). Only the contamination risks and prevention of enteric (intestinal) bacteria are presented. Other contaminants, including chemical (e.g., pesticides, pharmaceutical agents and toxins) and physical (e.g., metal fragments, dust and dirt) hazards are not discussed.

Slaughter process in the United States of America

Abattoirs

Small abattoirs may kill only a few animals daily while others kill as many as 300 or more per hour. Most large abattoirs kill only fat cattle (cattle which have been fed grain, usually at a cattle feedyard, typically for about 145 days). Fat cattle abattoirs primarily produce graded beef. Considerably fewer abattoirs kill cows (culls) and bulls. These plants primarily produce ground beef. Ritual (e.g., kosher and halal) slaughter of animals is usually performed at smaller establishments. Most large establishments in the USA are owned by three major corporations. Fewer owners may result in greater standardisation of processing practices and larger corporations may have a greater ability to invest resources into expensive sanitation equipment than smaller companies, but there also may be disadvantages in having the supply of beef across the country controlled by just a few corporations.

Supply of cattle

Most cattle are purchased for the packing establishment by cattle buyers employed by the establishment to travel to auction barns (marketing agencies selling cattle on commission openly at the highest bid), feedyards or cattle ranches to purchase cattle. There are approximately 43,000 beef cattle feedyards in the USA concentrated in 13, mostly midwestern and western, States. As a result, the conditions under which the cattle have been raised can differ widely.

Live animal procedures

Animals arrive in trucks at the abattoir receiving area where they are unloaded by abattoir personnel into holding pens. Usually animals are not marked with individual identification (although cull dairy cattle purchased though an auction barn have temporary back tags identifying the animal with a sequence number assigned by the auction barn and the auction barn identity). The abattoir will assign a lot number to each group of animals purchased and received together. Animals may be held at the abattoir for just a few hours or, on rare occasions, for several days before slaughter. When a lot is ready to be slaughtered, the abattoir personnel move the animals through chutes into the establishment.

Slaughter process

Typically, an animal is moved to the kill box where an employee of the abattoir stuns the animal with a captive bolt gun. Another employee loops a chain around one of the hind legs of the animal and the animal is hoisted up by the chain onto the moving line. The animal is killed by an employee who cuts the jugular vein and the carcass continues to move along the line past stations where employees further process the carcass. Processing includes removing the head and hide, evisceration, splitting the carcass into sides, trimming excess fat and carcass blemishes, washing, Food Safety and Inspection Service (FSIS) inspection, weighing, and moving the carcass into the chiller (2).

Prevalence of potential pathogens

The slaughtering process results in surface tissue contamination with counts of micro-organisms ranging from \(10^3\) to \(10^4\) colony forming units (CFU/cm\(^2\)) (1), which can be reduced 1 to 3 log units by various pathogen reduction procedures, leaving about 10 organisms/cm\(^2\). *Salmonella* has been isolated with prevalence rates between 3% and 95% from tissue, carcasses, processing equipment and employees at abattoirs (32), showing that there is considerable variation in microbial levels. In Washington State, a survey of cull dairy cows, a primary source of ground beef, found the prevalence of faecal shedding of *Salmonella* to be about 5 cows per 1,000 (17).

Location of contamination

The midline, neck and hind portion of the carcass have been found to be heavily contaminated areas (11, 18).

Sources of contamination

Effective intervention to reduce contamination of beef carcasses begins with determining potential sources of contamination. Tissues under the hide of healthy cattle are usually sterile (1); consequently, tissues become contaminated during the slaughtering process. Sources of meat contamination during slaughter may be classified as those associated with the animal, processing practices, abattoir facilities and employees. The extent to which potential contamination sources become hazardous to public health depends on management and unpredictable events or factors. Even in the best managed slaughter facilities, contamination may still occur. Fortunately, most bacterial colonies which have been isolated from beef carcasses have been non-pathogenic, although human pathogens such as *Salmonella*, *Campylobacter* and *Listeria* have been isolated also (11).
Animal/carcass sources

A major source of microbial contamination on the carcasses of beef is faeces (31). Faeces, as well as soil adhering to the animal, is carried into the abattoir on the hair, hide, hooves and tail of the animal. Parasites such as flies, grubs and worms carried by the animal into the plant also can be a source of microbial contamination. Infected body fluids such as urine, milk, blood, mucus, rumen fluid, intestinal fluid and fluid from excised abscesses can be other sources of microbial contamination of carcasses. Contact with lymph nodes, if excised, may also be a source of contamination (27).

The probability that a live animal is contaminated (both internally and externally) and the extent of contamination (pathogen load) depend on factors which can be affected by management before transport to the abattoir (on-farm and market factors), during transport, and while the animals are being held at the abattoir before slaughter.

On-farm/market factors

The health and immune system of the animal, as well as its history of treatment for disease, should be taken into account before the animal is transported to the abattoir. Animals should be clean before transport. Body condition may affect the pathogen load. Animals which are weak lie down more than others, thereby increasing the likelihood of contaminating the hide. Animals which are 'off-feed' may have a larger pathogen load than other animals. Certain enteric pathogens may have a selective advantage over other non-pathogenic enteric micro-organisms in the digestive tract of animals off-feed (3). Early detection, treatment and segregation of sick animals reduce transmission of disease to others and reduce the risk of transporting sick animals to the abattoir. Contact between animals at auction barns may increase the pathogen load.

Transport factors

Transport factors such as the type and cleanliness of transport conveyance, distance travelled and duration of journey, harshness of ride, density of animals in the conveyance and frequency of stops, may affect the pathogen load. Interruption of feeding just before transport, during transport, and while being held at auction barns and abattoirs affect the growth of potential pathogens in the rumen (3) and faecal shedding of bacteria (20). The number of calves which shed Salmonella has been found to increase after transportation (4).

Abattoir holding-pen factors

The length of time animals are held at the abattoir before slaughter can affect the pathogen load by increasing the probability of exposure and infection (20). Sanitation of walkways, pen floors, railings, feed and water affect the pathogen load. Steep walkways with sharp turns increase the likelihood that animals will fall and become contaminated or injured. Excessive prodding of animals to move them bruises tissue.

Non-ambulatory animals

Animals can arrive at the plant in a non-ambulatory condition or can become non-ambulatory after being received. Some plants refuse to accept such animals. Non-ambulatory animals ('downers') must be moved, usually by attaching a chain to a leg and dragging them or by use of a front end loader, to a separate area where they are held for inspection by a veterinarian who will determine whether they should be condemned, passed for slaughter as suspects, or held for further observation. Government regulations require that conscious downer animals be stunned before being dragged. These animals may have a higher pathogen load than other animals entering the abattoir.

Pregnant, lactating or periparturient cows

Periparturient cows or cows which deliver while in the holding pens at the abattoir may have a higher pathogen load than other cows. Lactating cows may have mastitis and may thus have higher pathogen loads than other cows.

Unpredictable factors

Season of year and weather can affect the pathogen load and while these are uncontrollable, the effect which these factors may have on pathogen load can be mitigated by management.

Processing sources

Contamination can occur at any point during processing. Although processing techniques vary depending on the abattoir, the basic steps are similar. Some processing steps/stations at which contamination may be more likely to occur are listed below. Skinning and evisceration are considered to be procedures which deposit large numbers of faecal organisms onto carcasses.

Kill box

The sides and floor of the kill box can accumulate dirt, faeces and body fluids. When a captive bolt gun is used, the bolt can be contaminated if it is not cleaned between each use. When the animal is shackled and hoisted onto the processing line, body fluids may splatter onto the carcass, other carcasses, employees, surfaces and equipment.

Sticking and bleeding

Spillage and splatter of body fluids can be a source of contamination during sticking and bleeding. Stick knives may spread contamination from the hide to the carcass surface or to internal tissues.

Head and shank removal

Spillage and splatter of body fluids during the removal of the head and shank can be a source of contamination.

Hide removal

The hide puller may splatter or aerosolise contamination. Sometimes abscesses may break and release pathogens.
Evisceration
When the carcass is opened and the viscera removed, spillage of rumen and intestinal fluids may contaminate the carcass, workers, processing utensils and viscera tables or trucks.

Splitting
Splitting of the sternum and carcass into 'sides' may splatter contamination. Carcasses can be contaminated if the saw is not thoroughly sanitised between cutting each carcass.

Abattoir facilities
Differences between and within abattoirs have been shown to be the most significant factors which might influence the bacterial load on beef carcasses. Bacterial load can be affected by time (shift, day, day of the week, season, year), cattle market class, carcass grade (fat thickness), and origin of the cattle (where they were sold to the abattoir).

Contaminants may originate from surfaces of employee hand railings, cooling fans, floors, walls, ceilings, doors, windows and processing equipment. Good plant sanitation practices and prevention of carcass contact with any surfaces reduce the risk of contamination. The sanitation of older plants may be harder to manage. Exposure to contaminants is affected by the length of the line, line speed, number of handlers, delays because of mechanical breakdowns and employee rest breaks, and the rapidity of cooling the carcass.

Abattoirs and Food Safety and Inspection Service employees
Employees, their clothing, and equipment may be a source of contamination. Bacteria have been isolated from the hands of plant workers along the entire processing line even after they have washed their hands. Salmonella was isolated from the hands of 52% of the workers who handled the hide in one study.

Risk reduction measures
Good sanitation practices
The best prevention of contamination is strict and vigilant good sanitation practices. Some live animal and slaughtering sanitation practices which might be considered are listed below.

Live animal procedures
a) Minimise the time held before slaughter
b) Minimise the time off feed and water
c) Keep pen floors clean, especially between lots
d) Wash and dry animals before they enter the plant
e) Provide animals with clean feed and water.

Carcass processing procedures
a) Use squeegees instead of water hoses to clean floors while carcasses are being processed; cleaning floors with water hoses may splatter carcasses with contaminated materials
b) Provide employees with clean clothing daily; outer wear (hard hats, aprons, boots, latex and mesh gloves) should be cleaned frequently during the day
c) Provide boot washes and insist that they are used
d) Provide easy access to sterilising equipment and insist that employees frequently sanitise knives and other tools used, especially between handling each carcass
e) Sanitise hand rails, tables, cutting boards, sharpeners and scabbards frequently throughout the processing day
f) Minimise carcass-to-carcass contact while sides move along the rail
g) Minimise the spread of contamination from one area (anatomical location) of a carcass to another
h) Minimise carcass-to-surface contact, such as carcass contact with railings and doors
i) Minimise contamination when removing the udder
j) Tie oesophagus to prevent spillage of stomach contents
k) Tie or bag the rectum to prevent escape of faeces (some plants also bag the tail until hide removal)
l) Minimise carcass-to-carcass contact while sides move along the rail
m) At the end of each work day or shift, sweep up debris and discard appropriately, clean floors, walls and equipment with an approved cleaning agent, according to the directions of the manufacturers and rinse with potable water; clean ceiling according to a schedule and when needed
n) Isolate, by walls or other partitions, areas of the plant where cross-contamination of carcasses is likely to occur (kill box, exsanguination, hide removal, head removal and cleaning, evisceration, splitting, rumen emptying and washing areas); isolate processing areas which precede hide removal from areas which follow hide removal
o) Use shields made from non-porous, easily disinfected material such as stainless steel to control splatter
p) Prevent fluids regurgitated from stunned animals from splashing onto carcasses, processing equipment and employees.

Microbial monitoring
Microbiological analysis of carcasses within the abattoir is a necessary step for monitoring beef carcass hygiene and, indirectly, the hygiene of the slaughtering practices. Microbiological analysis of structural and equipment surfaces can also be used to monitor the sanitation practices of the abattoir. Several methods can be used to enumerate bacteria on carcasses and other surfaces, such as total aerobic plate counts (APCs) measured in log base 10 colony forming units.
coli (generic), can also be used to particular strains such as E. coli (generic), can also be used to evaluate processing hygiene. Bacterial culture analysis, considered by most microbiologists to be the 'gold standard', requires at least 36 h to obtain results. As carcasses are stored typically only overnight before further processing and shipment, the information gained through bacterial culture cannot be used to identify carcasses which should receive additional sanitation. However, the information can be used indirectly to monitor the success or failure of sanitation practices. Many rapid diagnostic tests have been proposed to reduce the time to obtain results. Rapid tests could be used to determine whether additional sanitation of accidentally contaminated carcasses has sufficiently decontaminated the carcass. An adenosine triphosphate (ATP) bioluminescence assay has been shown to be effective in detecting generic microbial levels on beef carcasses (30, 31). An automatic genetic fingerprinting technique which will report the species of an already isolated colony has been developed. There has been much discussion in the literature about the following factors related to sampling practices:

a) area of the carcass to sample for bacterial contamination (hock, butt, anal area, rump, back, flank, neck, brisket, axilla, shank and whole carcass)
b) method of sample collection (swab, sponge, excision and collection of carcass rinse water)
c) frequency of sampling
d) number of samples which will account for variability encountered and the level of precision desired (15, 21).

The feasibility of microbial testing in the plant depends on the speed at which results are obtained and the cost of the test, including personnel costs. The accuracy, range of detection and repeatability of a microbial test, compared to similar tests, also must be considered before selecting a test. Repeatability of microbial tests can be poor, even when bacterial culture is the method used. Differences in bacterial counts of up to 2 log units have been found even when the same carcass and site were sampled. The time between contamination and sampling may be too short for microbial populations to increase to detectable levels.

Tests which estimate presence or absence of bacteria can be affected by many factors, and new tests become available frequently. Whichever test is chosen for use by a laboratory (either on-site or off-site), the test should be used for an extended period of time to establish baseline microbial count data for an abattoir, work station, process or shift, so that comparisons over time can be made. In addition, microbial tests must be performed consistently among personnel and over time to establish good baseline data. Deviations from the baseline microbial counts alert the abattoir to potential contamination problems and the possibility of inadequate sanitation practices. Comparisons among laboratories must be made carefully because differences in procedures can cause significant variations in results.

**Carcass treatment**

Several excellent reviews have been written which present methods for reduction of pathogens on beef carcasses (11, 25). Much laboratory research has been performed to identify antimicrobial agents and techniques which are effective in reducing microbial populations on tissue samples without affecting meat quality, but not all agents and techniques can reasonably be incorporated into carcass processing. Many plants use several procedures, in combination, to reduce populations of pathogens and spoilage microflora on carcasses.

The success of physically removing bacteria from carcasses depends, in part, on the speed at which the contamination is reduced. The longer bacteria reside on the carcass, the more difficult removal becomes because of the ability of bacteria to attach to tissue (9).

The value of an intervention is determined by comparing the reduction, if any, of bacterial counts on treated carcasses and untreated carcasses. This implies that some microbial populations will continue to be present on carcasses even after any intervention.

**Trimming**

Tissue observed to be contaminated or areas of the carcasses known to be susceptible to contamination during the slaughter process can be cut away with a knife and discarded. Trimming has been found to be both effective (26) and ineffective (19). The efficacy of trimming visible contamination depends on the skills and diligence of the employee and the sanitary condition of the knife used between trimming sites (25). Trimming may facilitate bacterial penetration into carcasses (1).

**Washing**

Spraying carcasses with cold or hot water has been shown to be effective and practical in reducing microbial populations. The process of washing has been automated and is often the final sanitation process before the carcass enters the cooler. Automated washing units use banks of spray nozzles which oscillate up and down. Effectiveness of mechanical washing depends on water quality and volume, force, angle and duration of spray, and the cleanliness and reliability of the spraying equipment. Water sprayed at high pressures may be more effective in removing surface bacteria from carcasses, but if pressures are too high, the water also may drive particles the size of bacteria into meat surfaces (1). Cold or hot water washing or spraying can spread microbial contamination from one location to another on carcasses, but washing also dilutes
bacterial contamination, so carcass washing is probably better than not washing to reduce bacterial contamination.

**Antimicrobial agents**

**Application of chlorinated water**

The effectiveness of reducing microbial populations on beef carcasses by washing the carcasses with chlorine solutions at various concentrations (pH), temperatures, pressures, washing times, and from various sources (calcium hypochlorite, chlorine dioxide and electrically generated sources) has been studied (5, 6, 22). Some studies report no difference in microbial populations between chlorine treated carcasses and control after seven or eight days of storage.

**Organic acid rinses**

Organic acids such as acetic and lactic acid have been found to be variably effective in reducing microbial populations on carcasses and are 'generally recognised as safe' (GRAS) additives (8, 12, 13). Other organic acids studied include propionic, citric, ascorbic and formic acids. The synergistic effect of combinations of organic acids has been studied (7). The effectiveness of antimicrobial agents depends on concentration, application temperature, exposure time, mode of application, fat thickness and the sensitivity of the microflora to the agent. High concentrations may produce bleaching of carcasses.

Use of alginate gels, which immobilise organic acids, may enhance the antimicrobial effect against some bacteria by keeping the acids in contact with contaminating microflora on the tissue for a longer period of time (28, 29).

**Other compounds**

Hydrogen peroxide, stannous chloride, potassium sorbate, sodium hydroxide, potassium hydroxide and ozone are other compounds which have been studied for efficacy in reducing microbial populations. Equipment requirements, employee safety, waste disposal, corrosiveness and costs may limit commercial adoption of many antimicrobial agents (25).

**Steam vacuum**

Steam vacuum stations placed along the processing line have been shown to be effective in reducing microbial populations (14). At the station, an employee vigorously sweeps the nozzle of the steam vacuum on an area of the carcass. The area is 'cleaned' by suction and a simultaneous delivery of steam or hot water.

**Steam pasteurisation**

Steam pasteurisation has been shown to provide uniform bacterial destruction over the carcass surface (24, 25).

**Temperature**

Spray chilling is used as a method of sanitising carcasses in the cooler. A fine mist of cold water is sprayed on carcasses in the cooler to speed the rate of cooling and reduce moisture loss. Chlorine (5), acetic acid (10) or lactic acid can be added to the spray to enhance reduction of the microbial populations.

**Gamma irradiation**

Gamma irradiation, applied after packaging, has been shown to be effective in reducing bacterial pathogens in meat, but irradiation does not remove physical contaminants and may be perceived by the consumer as dangerous.

**Regulations and Food Safety and Inspection**

**Service inspection**

Sanitation

In July 1996, the United States Department of Agriculture (USDA)/FSIS issued the final rule 'Pathogen reduction; hazard analysis and critical control point (HACCP) systems'. The regulations contained in this final rule require that all inspected slaughter facilities:

1. develop HACCP programmes for their operations
2. implement standard operating procedures for sanitation
3. implement a microbial testing programme as a measure of control of slaughter and sanitary dressing procedures (16).

The use of antimicrobial or cooling interventions during the slaughter process is not mandated in the new regulations, but is left up to individual establishments. Under the new system, the FSIS verifies the process control measures selected by the establishment for compliance with FSIS food safety performance standards.

**Post-mortem inspection**

Work stations within the abattoir are designated for post-mortem inspection by FSIS employees. In addition to inspecting tissue, inspectors observe the facilities, equipment and clothing of employees for cleanliness and maintenance along the entire line.

**Marketing**

Video marketing of cattle may reduce potential contamination when animals are in close contact at auction barns. Establishing strategic alliances may improve product quality because the alliance requires that each member (ranch, feedyard and processing plant) actively complies with production practices (specifications) imposed by the alliance. Financial incentives for producing live animals which arrive at the abattoir clean and in good body condition may be effective in reducing the level of incoming contamination. Substantial financial penalties may discourage the shipment of downer animals or animals in poor condition to processing.
establishments. 'Branded beef' (beef products which are labelled with the names of places where, or processes under which, they have been produced) may give consumers the power to influence pathogen reduction programmes by their selection of products based on real or perceived differences in safety among product brands.

Education
Continued development of quality assurance programmes by producer groups for all stages of food animal production will help ensure that good management practices are widely understood among all producers.

Conclusions
Microbial populations on carcasses probably can never be eliminated, only reduced. Control of pathogen load on carcasses should occur at many points during production. Reliance on any single intervention to reduce pathogens on carcasses will always be risky. Any intervention to reduce pathogens depends on constant vigilance by those who are responsible for implementation. As the major source of microbial contamination of carcasses is faeces carried into the plant on the hide, hair and hooves of animals, starting the slaughtering process with a clean animal is important. Live animal management practices which reduce the likelihood of faecal shedding of pathogens are important to reduce contamination. Good sanitation practices are the most important means of reducing contamination during the slaughter process. Effective and commercially practical methods for sanitising carcasses must be used, probably in combination and at several points during the slaughter process, to reduce contamination. Organoleptic inspection for detecting contamination and the effectiveness of sanitising must be augmented with microbiological testing. The new regulations which require inspected establishments to develop HACCP plans specifically to meet food safety performance standards should improve abattoir sanitation and result in reductions in microbial counts on carcasses. The abundance and diversity of microflora on live animals, on carcasses, in packing plants and within geographical regions probably change over time. The ability of micro-organisms to adapt, and the emergence of new pathogens such as E. coli O157:H7, are an admonition for continual efforts to reduce microbial contaminants in food products and in the establishments which produce such products.

Risques et prévention de la contamination des carcasses de bovins à l'abattoir aux États-Unis d'Amérique

J.C. Galland

Résumé
L'auteur décrit brièvement les techniques d'abattage des bovins de boucherie aux États-Unis d'Amérique. Le taux de contamination microbienne varie considérablement selon les établissements de transformation. Cet écart tient, essentiellement, à deux facteurs :

a/ la charge pathogène sur ou chez les animaux vivants pénétrant dans l'établissement ;

b/ les mesures d'hygiène appliquées par l'établissement.

La charge pathogène sur ou chez les animaux vivants dépend de l'exposition du milieu à des agents pathogènes, de la santé des animaux et des situations de stress susceptibles d'accroître l'excrétion microbienne (notamment l'impossibilité de s'alimenter ou de boire, le transport, les manipulations et la cohabitation avec d'autres animaux). L'auteur énumère les différents postes de transformation et les pratiques d'abattage qui constituent des sources potentielles de contamination des carcasses, ainsi que les parties des carcasses où la probabilité de contamination est la plus élevée. Il décrit également les mesures de réduction des risques de contamination au sein d'un établissement, notamment le traitement des carcasses au moyen d'agents antimicrobiens, le parage, le lavage, l'étuvage, le refroidissement et l'irradiation aux rayons gamma.
L'auteur donne quelques exemples de bonnes pratiques d'hygiène. La surveillance microbiologique permet de savoir si les mesures d'hygiène sont efficaces, mais l'utilité d'une telle surveillance dépend des recherches microbiologiques effectuées, des procédures et de la fréquence des prélèvements, de la rapidité d'obtention des résultats, ainsi que de la tenue régulière et précise de registres et de leur analyse. Les inspections sanitaires officielles visent à vérifier que les établissements de transformation se conforment à la nouvelle réglementation fédérale en matière de normes d'hygiène et de recherches microbiologiques devraient se traduire par une surveillance accrue garantissant le respect de bonnes pratiques d'hygiène.

Mots-clés

Riesgos y prevención de la contaminación de las canales vacunas durante las operaciones de sacrificio en Estados Unidos de América

J.C. Galland

Resumen
El autor describe brevemente y en términos generales el proceso de sacrificio del ganado vacuno en Estados Unidos de América. Los informes disponibles ponen de manifiesto una considerable variación de la prevalencia de contaminación microbiana en las instalaciones de procesado de la carne. Dos son los factores fundamentales que pueden explicar semejante variación:
a) la carga de agentes patógenos presentes en los animales vivos al llegar al matadero; y
b) los métodos de higiene utilizados en el matadero.
La carga de patógenos en los animales vivos depende de la exposición del entorno a los contaminantes, así como del estado de salud del animal y de las situaciones de estrés susceptibles de incrementar la excreción microbiana, como la privación de alimento y agua, las condiciones de transporte y manipulación o la cohabitación con otros animales. Se enumeran aquí las operaciones de tratamiento y las prácticas de sacrificio que pueden provocar la contaminación de las canales, así como los puntos anatómicos más susceptibles de resultar contaminados. Entre las medidas de reducción del riesgo de contaminación que pueden aplicarse en un matadero figuran el tratamiento de las canales con agentes antimicrobianos, el despiece, el lavado, el chorro de vapor, el enfriamiento y la irradiación con rayos gamma.
Se describe también un conjunto de buenas prácticas de higiene. El control de la presencia microbiana es un paso necesario para determinar la eficacia de las prácticas de higiene, aunque su utilidad depende de las pruebas microbiológicas utilizadas, de las técnicas y la frecuencia de muestreo, de la rapidez con la que se dispone de los resultados y de un mantenimiento y análisis adecuados y escrupulosos del registro de resultados. La inspección federal de los mataderos,
destinada a garantizar el cumplimiento del nuevo reglamento federal sobre la aplicación de procedimientos normalizados de higiene y de detección microbiológica, debería llevar a un mayor grado de vigilancia en lo que se refiere a las buenas prácticas de higiene. Se describen someramente los actuales procedimientos de inspección organoléptica que aplican las autoridades públicas.

**Palabras clave**

**References**


