Public health hazards from small ruminant meat products in Europe

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Summary
Foodborne diseases, in particular those related to meat and meat products, have recently become a matter of great public concern. Sheep and goat meat can transmit infections and diseases either through handling during preparation procedures or as a result of ingestion by the consumer. The authors highlight the second route of contamination in relation to meat and meat products from small ruminants in European countries.

Among the most important diseases transmitted by mutton and goat meat, toxoplasmosis remains the greatest threat, particularly in immuno-compromised people and in pregnant women. Other pathogens which may be associated with the consumption of meat from small ruminants include: Clostridium perfringens, Cryptosporidium parvum and Campylobacter jejuni. As with other ruminant species, Escherichia coli O157:H7 can be considered as an emerging pathogen, for which control efforts must be made. The classical zoonoses (brucellosis, Q fever, hydatidosis) are also presented here, although the major source of contamination for these diseases remains contact with infected animals or the handling of carcasses. The fact that the association of foodborne diseases with mutton and goat meat is less frequent than with the meat of other animal species should be noted, for the following reasons:

a) lower levels of production
b) less intensive production, leading to a weaker microbial contamination
c) mutton and goat meat are subjected to processing less often than other meats
d) the usual boiling or cooking processes.

Keywords

Introduction
Meat and meat products are important vehicles of foodborne illnesses in European countries. There are two routes by which diseases may be spread through meat and meat products to humans. The first route is direct contact, and includes streptococcal skin infections, anthrax, viral and fungal diseases, brucellosis, Q fever and other organisms which affect those handling carcasses and raw meat. In European countries, these infections are largely confined to workers in the meat and livestock industries (2, 59). The second route of contamination is ingestion, which may cause illness in the consumer and may affect larger numbers of people (32, 49, 56). This paper focuses on pathogens which are transmitted by the consumption of contaminated products.

Sheep and goats can transmit diseases and infections through meat and meat products, although the number of foodborne disease outbreaks associated with meat from small ruminants is rather low. An epidemiological survey performed in England and Wales between 1960 and 1989 and focusing on Salmonella, Clostridium perfringens, Staphylococcus aureus and Bacillus spp. outbreaks showed that lamb and mutton were responsible for less than 6% of foodborne disease cases in humans (56) whereas poultry, pork and beef have been
incriminated in 49%, 18% and 27% of outbreaks, respectively. The difference between this and the case for meat from other species (poultry, pork, beef) is particularly significant in a country where mutton is a favourite meal.

This paper lists only those pathogens which may be transmitted through meat from small ruminants in European countries: it is important to note that most pathogens are capable of contaminating a wide range of animals and a wide variety of organs or fluids within a single species. The authors have not taken into account pathogens which may be transmitted by cross-contamination.

Pathogens mainly transmitted by meat from small ruminants

**Toxoplasma gondii**

*Toxoplasma gondii* is an obligate intracellular protozoan parasite (family Apicomplexa) which is distributed worldwide, and is of major concern for the health of human beings and domestic animals. This parasite infects a broad spectrum of vertebrates including birds. Domestic and feral cats are the definitive hosts, but other mammals, including humans, can be infected through congenital transfer following the ingestion of undercooked meat containing oocysts or tissue cysts, or by the ingestion of sporulated oocysts from soil contaminated by cat faeces (Fig. 1) (11, 14, 60). In humans, *T. gondii* usually causes asymptomatic disease. However, the reactivation of chronic infection in immuno-compromised patients (e.g., reactivation of infections of the focal central nervous system in patients with AIDS) and congenital toxoplasmosis (resulting from primary infection during pregnancy), present severe and life-threatening clinical events (22).

In sheep and goats, *T. gondii* infection results in abortions or asymptomatic infections (35). Various surveys in France have illustrated the importance of toxoplasmosis as one of the main causes of abortion in ewes and goats (16, 17). Following asymptomatic infection or abortion, lambs and kids become the main reservoirs of tissue cysts and represent one of the main sources of risk of infection through raw meat. *T. gondii* may also be carried in beef and pork, as recorded particularly in the United States of America (USA). Two other sources of infection are cats and the environment (oocyst-contaminated fruit, vegetables or other vectors) (11).

In the absence of vaccination of humans (5), immuno-compromised people and seronegative pregnant women are advised to eat well-cooked meat or meat frozen prior to preparation, to wash fruit and vegetables and to avoid contact with cat faeces and cat litter. Control measures include the vaccination of ewes, goats and cats. Despite the fact that research in this area is rather intense, only one live vaccine is at present available and use of this is limited to a few European countries (19).

Although there has been no report suggesting the involvement of *Neospora* sp. in human diseases, this protozoan (which is related to *T. gondii*) may be considered a possible foodborne pathogen, as it is increasingly involved in ruminant pathology (4).

Pathogens possibly transmitted by meat from small ruminants

**Bacteria**

*Clostridium perfringens*

*Clostridium perfringens* is an inhabitant of the intestinal tract of humans and animals, and therefore probably contaminates meat surfaces through faecal contamination. *C. perfringens* is characterised by the development of spores which can survive for a long time in the environment. The disease in both animals and humans is associated with the production of as many as seventeen exotoxins capable of resisting high temperatures which vary according to the strain of *C. perfringens* under consideration. Four major toxins form the basis for division of the species into five toxigenic types. Although not considered a major toxin, *C. perfringens* enterotoxin (CPE) is the principal toxin involved in foodborne illness caused by *C. perfringens*, and is considered to be a virulence factor in animal strains. The CPE toxin may be produced by any of the five toxigenic types (57). The disease in humans is often benign and symptoms include diarrhoea with abdominal pain, without fever or vomiting. The risks for public health are generally associated with the consumption of meat prepared in very large quantities and, as a consequence, inadequately cooked (27, 39).
**Staphylococcus aureus**

All domestic animals, and sheep and goats in particular, develop different diseases associated with *Staphylococcus aureus*; this bacterium is often isolated in cases of mastitis, cutaneous lesions, abscesses, etc.

Although *S. aureus* is an important pathogen for animals, one of the main sources of *S. aureus* infection in humans comes from humans themselves who can contaminate meat or even all meals during preparation (27). The disease in humans is a typical toxic-infection associated with the production of enterotoxins (8) with severe vomiting, abdominal pain and sometimes diarrhoea and headaches. The duration is short (one day) but the symptoms are severe.

The animal product from which *S. aureus* is transmitted is principally milk. Raw milk and cheese made from raw milk are important vectors. Meat or meat products do not represent a major risk.

**Campylobacter jejuni**

In sheep and goats, campylobacteriosis is characterised by abortions, stillbirths and weak lambs or kids. Two species have been recognised as causative agents of this disease, namely: *Campylobacter jejuni* and *C. fetus subsp. fetus*. The infection is highly contagious and may cause up to 70% of ewes to abort when the organisms are newly introduced into a flock. Susceptible ewes or goats may acquire infection through ingestion of forage contaminated with foetal material or uterine discharge. Other sources of infection may include the faeces of carrier sheep or other mammals and various wild birds (20).

The main source of contamination for humans may come from contact with aborted ewes; this infection leads to enteritis. Meat is not an important source of contamination and the risk may be considerably reduced if the meat is well cooked. Milk may be also a source of contamination (13, 44).

**Escherichia coli**

*Escherichia coli* is an important foodborne pathogen. The organism can produce different toxins and *E. coli* strains have been classified into four categories according to their properties (27):

- enterotoxigenic *E. coli* (ETEC)
- enteroinvasive *E. coli* (EIEC)
- enteropathogenic *E. coli* (EPEC)
- verotoxin-producing *E. coli* (VTEC) or enterohaemorrhagic *E. coli* (EHEC).

*E. coli* O157:H7 belongs to the final category, and produces toxins which are similar to the Shiga toxin of *Shigella dysenteriae* and distinct from *E. coli* heat-stable and heat-labile toxins. This pathogen was first described in 1982 and is now recognised as an important cause of bloody diarrhoea and renal failure (6, 21). The reason for the emergence of *E. coli* O157:H7 remains elusive. Although no single process or event can be identified as the contributing factor to the emergence of this pathogen, changes in the livestock industry, in food processing and the food industry and in consumer preferences may have created favourable conditions for the spread of the pathogen through and into animal and human populations (6).

For most pathogenic *E. coli* strains, symptomatic and asymptomatic human carriers are believed to be the principal reservoir. This is not true for *E. coli* O157:H7, for which the intestinal tract of cattle and other food animals, including sheep, are a reservoir. Hence, raw foods of animal origin are likely to be vehicles of *E. coli* O157:H7 through faecal contamination during slaughter or milking procedures (6). Recent reports have described the isolation of this serovar from samples of domestic sheep meat and from imported sheep gut, which suggests that *E. coli* O157:H7 may not have been detected in domestic animals other than cattle because the other animals were less intensively examined for the organism (9, 10, 37).

The use of good manufacturing practices in the processing of foods of animal origin and adequate heating of such foods before consumption are important control measures for the prevention of *E. coli* O157:H7 infection (61).

**Yersinia enterocolitica**

*Yersinia enterocolitica* is a significant cause of gastroenteritis in European countries. This bacterium belongs to a group of bacteria including both well-established pathogens (*Y. enterocolitica* O:3, O:9, O:8 and O:5) (27) and a range of environmental strains which are ubiquitous in various ecosystems (36). *Y. enterocolitica* is considered a foodborne pathogen, despite the following:

- a) the frequent extra-intestinal manifestations such as hepatitis, endocarditis and arthritis disagree with this source of infection
- b) attempts to isolate the bacterium from a suspected food source have seldom proved successful (33, 36).

However, there is indirect evidence that pork and pork products are an important source of human infection with *Y. enterocolitica* O:3 and O:9, the serovars most virulent for humans. The ability of *Y. enterocolitica* to grow in refrigerated foods should also be noted. Raw milk or pasteurised milk can be contaminated by this pathogen.

Although meat or meat products from sheep and goats have never been incriminated in outbreaks of foodborne disease caused by *Y. enterocolitica*, small ruminants can harbour the bacterium and therefore these products should not be disregarded as a possible source of contamination (50).
Listeria monocytogenes

Listeria monocytogenes, the causative agent of listeriosis, is a small, Gram-positive, facultative intracellular bacterium. L. monocytogenes can be isolated from many environmental sources, including soil and silage, and from many animal species. In sheep and goats, L. monocytogenes is mainly responsible for abortions and encephalitis. The clinical picture in humans and animals is characterised by septicaemia, meningitis or abortions. The first three weeks of age, old age, neonatal diseases and treatment with corticosteroids or cytotoxic drugs may act as predisposing factors. Human listeriosis has been consistently associated with the colonisation of the pregnant uterus or the central nervous system by L. monocytogenes. In animals, Listeria may be shed in the milk with or without signs of mastitis. Since the 1980s, the role of food as a vehicle for Listeria infections in humans has been recognised (24). Listeria are widely distributed in the environment. Dairy products and, less importantly, meats and fish products have been involved in outbreaks of human listeriosis. Given that complete eradication of Listeria spp. from all foods is impossible, the implementation of procedures to reduce the development of the organism in raw products is very important (23).

Brucella

Brucellae are slow-growing, aerobic, Gram-negative rods which can multiply intracellularly and can infect a wide range of mammals causing brucellosis, a disease of world-wide distribution. Goats and sheep are the natural hosts and reservoirs of Brucella melitensis, and transmit the infection to many other species, including man. The infection causes abortion, sterility and decreased milk production in ruminants. In humans, the disease is often severe and long-lasting, characterised by malaise and recurring fever. The transmission to man occurs by direct contact with infected animals, or by consuming contaminated unpasteurised milk, milk products or cheese. Abattoir workers handling infected ruminants, or contaminated animals. In addition, the disease can be spread by inhalation of spores. As the disease is fatal in small ruminants, meat is not considered a vehicle for transmission in animals is ingestion of spores present in soil capable of surviving for more than 50 years. The major route of transmission in animals is ingestion of spores present in soil during periods of grazing (55).

Salmonella species

Salmonella is the generic name of a group of more than 2,000 biologically and serologically related Gram-negative, rod-shaped bacteria. Ubiquitous serovars, such as S. Typhimurium, affect both man and a range of animals, including sheep. The serovars cause asymptomatic carriage (38), enteritis, abortion or septicaemia in animals. The infected animals excrete bacteria and thus perpetuate a variety of environmental contamination methods and routes of infection. S. Abortusovis, a serovar which is highly adapted to sheep, produces no symptoms in man (43). Salmonellae are among the most common causes of bacterial food poisoning in humans. The symptoms of human salmonellosis include diarrhoea, abdominal cramps, fever and vomiting, usually within 24 hours of eating the contaminated food, and are more severe in the elderly, infants, or AIDS patients. The majority of human infections are derived from eating contaminated foods. The most commonly incriminated foods are those of animal origin and include meat, milk and eggs. The incidence varies according to agricultural practice and hygienic standards during slaughter (54) and subsequent handling. Sources other than raw meats include water, insects, food handlers and ingredients added after cooking, to name only a few. To reduce the incidence of salmonellosis, prevention and control procedures should be implemented to cover all levels of meat production, from husbandry to consumption. The limited available data indicate the low frequency of involvement of sheep meat in foodborne salmonellosis (28).

Bacillus anthracis

Bacillus anthracis is the cause of anthrax in herbivores and humans. The disease is most commonly characterised in ruminant species by an acute, fatal course resulting in both bacteraemia and toxæmia. The septicaemic condition is characterised by a failure of the blood to clot, inducing bloody discharge from the nose and mouth at death. On exposure to air, the organism has the ability to produce spores which are capable of surviving for more than 50 years. The major route of transmission in animals is ingestion of spores present in soil during periods of grazing (55).

Anthrax is endemic in many tropical and subtropical regions of the world, but is very rare in European countries. Anthrax is an important zoonotic disease which is usually transmitted by direct handling of hair, wool, skins or carcasses of infected or contaminated animals. In addition, the disease can be spread by inhalation of spores. As the disease is fatal in small ruminants, meat is not considered a vehicle for B. anthracis, but very few cases in humans have been described after ingestion of meat from goats and sheep dying of anthrax (12).

Parasites

Cryptosporidium parvum

Cryptosporidium spp. are intracellular parasitic protozoa which are responsible for diarrhoeal illness in humans and many animals (60). In immuno-competent individuals, C. parvum usually causes short-term gastroenteritis which is cured spontaneously. In contrast, young people and immuno-compromised individuals may suffer more severe gastroenteritis which can be fatal.
The parasite is infective to a wide spectrum of hosts: *C. parvum* is the species most often responsible for diarrhoeal diseases in mammals, including humans. The life-cycle is completed within one host, and large numbers of infective oocysts are passed in the faeces. Evidence of cross-transmission of *C. parvum* among mammals suggests the probability of zoonotic transmission to humans. Oocysts are environmentally resistant and are fully infectious when passed in the faeces (40).

Human infections may be transmitted by livestock: cattle, particularly dairy and meat calves, are commonly infected with cryptosporidia. The widespread oocyst contamination on farms and in the environment provides many potential routes of infection. Water-borne outbreaks due to *C. parvum* have been also reported.

The reservoirs and transmission routes of *Cryptosporidium* spp. suggest a risk of human infection through contaminated food. Livestock and livestock-derived products, such as raw milk and meat products, have been identified as potential sources of infection. Foodborne cryptosporidial infections are probably underdetected because of the small numbers of oocysts present and the difficulties encountered with regard to the diagnosis.

A recent survey in Spain has demonstrated that *C. parvum* was the most frequently detected agent in both diarrhoeic lambs (45%) and goat kids (42%). The high prevalence of infection and the strong association between infection and diarrhoea suggest that *C. parvum* is the most frequent cause of diarrhoea in lambs and kids and one of the most pathogenic agents (43). The high prevalence of *C. parvum* in lambs and goat kids suggests that these species may be an important source of contamination of humans through meat and meat products.

**Echinococcus granulosus**

*Echinococcus granulosus* is a parasite which has both an adult stage and a larval stage. The larval stage is found mainly in sheep and goats, but can also be recorded in cattle, pigs, horses and humans, whereas the final host for *E. granulosus* is the dog (Fig. 2) (1). In humans, *E. granulosus* induces hydatid cysts in the liver and/or the lungs. The disease is severe, difficult to diagnose and often leads to surgical interventions with dramatic consequences (18).

Prevalence of this zoonosis has considerably decreased in European countries since 1970 with the implementation of adequate control measures in abattoirs (e.g., a ban on dogs in abattoirs). Most cases recorded in France and in other European countries are associated with the use of traditional rites of slaughter, or with a lack of effective control measures in abattoirs which are often in rural areas. In Central Europe, the infection rate of *E. granulosus* among dogs is less than 1% and, according to meat inspection statistics, less than 0.008% of sheep, pigs or horses in Germany carry *E. granulosus* at a larval stage (51).

Meat from sheep or goats is not directly involved in the contamination of humans, but may be contaminated by eggs from infested dogs. The control of this parasitic disease is facilitated by removing dogs from abattoirs and by ensuring that sheep or goat viscera which contain hydatid cysts are not fed to dogs.

**Giardia duodenalis**

*Giardia* (G. *duodenalis* and G. *lamblia*) infection is associated with diarrhoeal diseases among infants and young children in both industrialised and developing countries. *G. duodenalis* and *Entamoeba histolytica* constitute the two most common intestinal protozoan parasites affecting man. This parasite is present in numerous domestic animals (cats, cattle, sheep, dogs, goats) and in wild animals (rats); the genetic characterisation of various isolates has demonstrated a relative genetic identity between isolates from humans and animals and an extensive diversity between isolates from humans, interpreted as evidence for zoonotic transmission of the parasite (25, 27, 60).

As lambs and other young domestic animals (kids, calves) are often infested by *G. duodenalis* (58, 64), the possibility of transmission by meat or meat products cannot be excluded, although the major source of contamination for humans is water or food contaminated by water containing faecal material.

**Fasciola species**

Liver fluke disease, or ‘fascioliasis’, is a parasitic disease found world-wide which affects sheep, goats, cattle and buffaloes, as well as other domestic ruminants. The common causative agents are *Fasciola hepatica* and *F. gigantica*; these parasites require various species of *Lymnaea* (fresh water snails) as intermediate hosts. In Europe, only *F. hepatica* is present. In
the definitive host and following ingestion of contaminated grass, metacercariae penetrate the intestinal wall and migrate through the liver parenchyma to the bile ducts where maturation into adult flukes occurs, which induces typical lesions in this organ. The disease in animals is characterised by weight loss, diarrhoea and poor appetite (55).

Humans may be infested by the ingestion of salad contaminated with metacercariae. The ingestion of uncooked liver from infested animals is not considered a source of contamination for humans (1).

Pathogens of sheep and goats for which no transmission by meat has been demonstrated

**Chlamydia psittaci**

The *Chlamydia* species, members of the order *Chlamydiales*, are obligate intracellular pathogenic bacteria. The genus is composed of four species: *C. trachomatis*, *C. psittaci*, *C. pneumoniae* and *C. pecorum* (53). Only *C. psittaci* and *C. pecorum* infect small ruminants with a wide variety of clinical signs, including arthritis, keratitis, pneumonia and enteritis. However, the principal symptom is abortion at the end of gestation. Although these pathogens are not frequently involved in human diseases, the major route of human contamination is contact with placentas and foetal fluids during abortion and/or lambing. Increased pathogenicity of some strains of *C. psittaci* for humans has sometimes been noted. At present, no study demonstrates the persistence of this bacteria in previously eviscerated carcasses. One of the potential risks for processing workers could be the removal of the udders of infected animals.

The occurrence of *C. psittaci* in birds remains an important cause of psittacosis (1, 30).

**Scrapie**

Scrapie in sheep and goats is endemic in parts of Europe and the USA (52). The disease is the prototype of transmissible spongiform encephalopathies (TSEs) found in humans and animals. These TSEs cause progressive degenerative disorders of the central nervous system and result in death. There is no doubt that scrapie is an infectious disease, but the nature of the causal agent remains elusive. The presence of nucleic acids is the subject of continuous debate, and the prion hypothesis, which suggests a protease resistant protein \(PrP^{Scrapie}\) derived from a normal host protein, is still very popular (47).

Bovine spongiform encephalopathy (BSE) has occurred in the United Kingdom (UK) and sporadically in a few other countries since 1985-1986 (62, 63). Concentrated feeds containing meat-and-bone meal produced from bovine, ovine and other animal wastes provided the vehicle for the spread of the disease. The epidemic was probably initiated in 1981-1982 when a sudden decline in the use of solvents in rendering plants allowed a low incidence of scrapie-like infection to occur in cattle. Subsequently, the epidemic was driven by the recycling of infected cattle material (34). The principal animal health control measures have been bans on the feeding of animals with bovine offal, whereas human health has been protected by compulsory slaughter and destruction of suspect and contact animals and by a prohibition on the use of specified bovine offal in food.

The recent identification of an apparently new variant of Creutzfeldt-Jakob disease in the UK has led to the hypothesis that this new disorder is causally related to the transmissible agent responsible for BSE (7, 31). Current concerns regarding BSE have led to questions about the risks of scrapie, a similar or identical disease of sheep and goats. This disease has existed for 200 years, and vast quantities of meat and offal from affected animals have obviously been consumed over the last two centuries, with no apparent human disease consequence. However, possible transmission of the BSE agent to sheep and goats, which is feasible by experimental infection through the oral route, has led to the reinforcement of measures to control scrapie both on farms and in food, by imposing a ban on the use of some sheep and goat products (central nervous system, spinal cord, spleen).

**Leptospira species**

The genus *Leptospira* includes numerous serovars and has been identified in many domestic and wild animals. *L. interrogans* serovars *hardjo* and *pomona* are the most prevalent in domestic and wild ruminants (55).

Leptospirosis is a zoonotic disease. In animals, most leptospiral infections are subclinical and are associated with an intermittent but persistent shedding in urine. Abortions have been described in ruminant species.

Sheep and goats are maintenance hosts of *Leptospira* spp. (29), but meat or meat products from infected animals are not considered to be vehicles for transmission to humans. The major source of infection for humans, and for animals, is urine or water contaminated by urine from infected animals (including rats). In humans, leptospirosis infection is usually an occupational disease.

**Coxiella burnetii**

Q fever is a zoonosis caused by *Coxiella burnetii* (42, 48). This pathogen, the only species in the genus, has an obligate intracellular life-cycle. In sheep and goats, the main clinical feature is abortion and/or the lambing of weak products. During abortion or lambing, numerous particles are shed by associated membranes and foetal fluids (42). The respiratory route is the main route of human contamination (30). Work in abattoirs also carries a high risk of contamination: lymph
nodes or udders (and, less commonly, meat), may contaminate processing workers who eviscerate carcasses (30). Seropositivity has been noted in veterinarians and other humans in close contact with animals (41). Although no report of contamination of meat has been substantiated, control measures would require the use of gloves and masks by meat processing workers in abattoirs.

Miscellaneous pathogens

Various other pathogens, for which information is scarce in regard to transmissibility of the pathogen to humans through meat or meat products, are responsible for diseases in sheep or goats. Included in this group are Corynebacterium pseudotuberculosis, the causative agent of caseous lymphadenitis (46) (very few cases of human diseases have been recorded and have always been associated with close contact with sheep with abscesses), Mycobacterium paratuberculosis, the causative agent of paratuberculosis (Johne's disease: the aetiological link between Crohn's disease and M. paratuberculosis infection in humans remains very controversial), Pasteurella spp. (an important respiratory pathogen), as well as mycoplasmas and most viral diseases of sheep and goats such as the Orf virus (a zoonosis which is transmitted by contact with skin lesions), maedi-visna virus, caprine arthritis/encephalitis virus, etc.

The potential for meat to transmit pathogenic and non-pathogenic organisms resistant to bacterial drugs should not be overlooked. Even though the importance of this antibiotic resistance transfer has yet to be fully evaluated, judicious use of antibiotics and hygienic practices at abattoirs will help to reduce bacterial drug resistance in man and animals.

Conclusions

As ways of life and food habits are constantly changing, particularly in industrialised countries, the control of foodborne diseases from meat and meat products is becoming increasingly important. Control must combine at least three complementary approaches:

- the 'hazard' which causes foodborne illness, i.e., bacteria, parasites or viruses, must be correctly identified. Gene amplification protocols have an important potential for detecting foodborne microbial pathogens, particularly in meat. However, this methodology requires confirmation in large-scale studies before gaining widespread acceptance within the regulatory agencies and the meat industry
- a sound knowledge is necessary of the conditions in which the pathogen is able to develop, so that the correct methods of product preparation and cooking can be followed and the risk for public health can be reduced considerably
- a knowledge must be acquired of individual susceptibility which can influence the outcome of the infection (e.g., immuno-deficiency, pregnancy, age).

All of these parameters must be integrated in a global risk analysis in order to prevent — or at least to reduce — the occurrence of foodborne diseases.

The concept 'healthy food from healthy animals' illustrates the importance of preventing diseases in animals. As a result of long-standing involvement in the meat industry and in the preventive approach adopted in the practice of food-animal medicine, members of the veterinary profession can continue to make a considerable contribution to improving the safety of milk, meat and meat products (19).

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procédures de préparation, soit par la voie alimentaire. Les auteurs étudient ce deuxième mode de contamination et consacrent leur analyse aux viandes et produits carnés provenant de petits ruminants dans les pays européens. Parmi les principales maladies transmises par la viande de mouton et de chèvre, la toxoplasmose demeure la menace majeure, en particulier pour les personnes immuno-déficientes et pour les femmes enceintes. Les autres micro-organismes pathogènes pouvant être associés à la consommation de viande de petits ruminants sont : Clostridium perfringens, Cryptosporidium parvum et Campylobacter jejuni. Comme chez les autres espèces de ruminants, Escherichia coli O157:H7 peut être considéré comme un agent émergent qui nécessite des mesures de prévention renforcées. Les auteurs se penchent également sur les zoonoses classiques (brucellose, fièvre Q, hydatidose), même si, pour ces maladies, la principale voie de contamination reste le contact avec les animaux infectés ou la manipulation des carcasses. Il convient de noter que la viande de mouton ou de chèvre occasionne moins de toxi-infections alimentaires que celle d’autres espèces animales, pour les raisons suivantes :  
  - niveau de production plus faible ;  
  - production moins intensive, donnant lieu à une contamination microbienne moins importante ;  
  - faible pourcentage de viande de mouton et de chèvre subissant une transformation ;  
  - habitude de consommer ces viandes bien cuites ou bouillies. 

Mots-clés  

Riesgos en materia de salud pública que plantean en Europa los productos cárnicos derivados de pequeños ruminantes  
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Resumen  
Las toxi-infecciones alimentarias, en especial las relacionadas con la carne y los productos cánicos, vienen suscitando en los últimos tiempos una gran inquietud pública. La transmisión de infecciones y enfermedades por la carne de cabra y oveja puede producirse durante su manipulación en el proceso de tratamiento o a resultados de su ingestión por el consumidor. Los autores centran su análisis en esta segunda vía de contaminación, concretamente en la carne y los derivados cánicos de pequeños ruminantes en los países europeos. De entre las enfermedades más importantes que se transmiten por la carne de cabra u oveja, la toxoplasmosis sigue constituyendo la principal amenaza, especialmente para personas inmunodeprimidas y mujeres encintas. Otros patógenos que pueden venir asociados al consumo de carne de pequeños ruminantes son: Clostridium perfringens, Cryptosporidium parvum y Campylobacter jejuni. Como sucede con otras especies de ruminants, Escherichia coli O157:H7 puede considerarse un patógeno de reciente aparición, para cuyo control es preciso tomar medidas. Los autores incluyen en su presentación a las zoonosis clásicas (brucelosis, fiebre Q, hidatidosis), aunque para estas enfermedades el contacto con animales infectados o la manipulación de canales sigan constituyendo la principal fuente de contaminación. Cabría recordar el hecho de...
que la carne de cordero o cabra ocasiona menos toxi-infecciones alimentarias que la carne de otras especies, por las siguientes razones:
- el menor nivel de producción;
- el carácter menos intensivo de la producción, que redunda en un grado menor de contaminación microbiana;
- el menor porcentaje de transformación que sufre la carne de cordero y cabra;
- el hábito de consumir esta carne bien cocinada o hervida.

Palabras clave
Carne de cabra - Carne de cordero - Enfermedades de los caprinos - Enfermedades de los ovinos - Europa - Microorganismos responsables de toxi-infecciones alimentarias - Salud pública.

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