Yersinia in effluents from the food-processing industry

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Summary: Yersinia enterocolitica and Yersinia pseudotuberculosis are current sources of pathogenic strains in humans and animals. Yersiniae infections occur throughout the world, but are most prevalent in regions with moderate and subtropical climates. In Australia, Central Europe and North America, cases of human infections with Yersinia enterocolitica now rank in third place. The food-processing industry may influence the epidemiological situation in different ways. Effluents which contaminate the environment may originate from slaughterhouses; e.g. from sewage contaminated with faeces from the lairage or contaminated effluents from the actual slaughter areas. The carcasses may serve as carriers of the organisms to the food-processing plants where they eventually contaminate the processed foods. Rodents and pests may also be carriers.

Pathogenic Y. enterocolitica and Y. pseudotuberculosis strains mainly occur in swine and pork. The ability to multiply under refrigeration and in vacuum-packaged products means that pathogenic Y. enterocolitica can cause foodborne diseases. If a plant harbours any pathogenic Yersiniae, transfer of the contaminant to the sewage is possible. Although pathogenic Yersiniae from infected animals can survive in sewage and in surface waters, the role of properly treated sewage in the transmission of yersiniosis seems to be of minor importance. If the recommendations for modern slaughter techniques are properly followed, the spread of pathogens in the slaughterhouses and, subsequently, into other food-processing plants can be minimised.


INTRODUCTION

The first isolation of the organism causing plague was described by Yersin in 1894; the genus Yersinia was established in 1944 by Van Loghem. Formerly, members of the genus Yersinia were recorded as Pasteurella. Yersinia enterocolitica ("Pasteurella X"), Yersinia pseudotuberculosis and Yersinia pestis are well-known sources of pathogenic strains in humans and other warm-blooded animals. However, the genus Yersinia, which belongs to the Enterobacteriaceae family, is comprised of eight further, predominantly apathogenic, species: Yersinia frederiksenii, Yersinia intermedia, Yersinia kristensenii, Yersinia rohdei, Yersinia aldrovae, Yersinia

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mollaretii, Yersinia bercovieri and Yersinia ruckeri (the latter is probably not a true Yersinia). The latter eight species are mostly found in the environment, though they may also be found as saprophytes in both warm- and cold-blooded animals (8). Y. mollaretii, Y. intermedia and Y. frederiksenii adapt to surface waters (7, 8).

Yersiniae infections are distributed world-wide, but are most prevalent in regions with moderate and subtropical climates. Yersiniae are capable of growth at low temperatures, even those approaching 0°C. This property, which is one of the causes of the seasonal occurrence of Yersiniae in slaughter animals and in humans, is useful for enrichment procedures which allow isolation at 4°C. Isolation of Y. enterocolitica and Y. pseudotuberculosis are most frequently recorded in autumn and winter.

Members of the genus Yersinia can be isolated by diverse enrichment procedures and by selective media (24, 62). Several biochemical reactions have been used to identify the species and their biogroups (8, 61); serological methods have been used to differentiate strains. In the case of Y. enterocolitica, phage-typing methods have been also employed (11, 41). At present, 60 O-antigens and 44 H-antigens have been defined; this brings to 214 the number of Yersinia serovars for the entire genus (6, 8).

Aleksic and Bockemühl (5) have suggested a separate serotyping scheme for Y. enterocolitica. Nineteen serovars are known to cause diseases in humans and animals. In Europe, Japan, Australia and Canada, the serovars O:3, biovar 4, O:5,27 and O:9 are most important (Table I); in the United States, the most important serovar is O:8 (18). Species-specific H-antigens may be used to differentiate Y. enterocolitica from the other Yersiniae (8).

Thal and Knapp (56) established the serotyping scheme for Y. pseudotuberculosis, which currently consists of 62 serovars. All O-groups (O-I to O-VII) have been isolated from humans. Only O-VI and O-VII occur in Japan, while O-I, O-II and O-III are the principal isolates in Central Europe (8).

Y. enterocolitica in humans causes acute gastrointestinal disorders and pseudoappendicitis which, depending on the immune status, can sometimes be fatal. Extramesenteric forms may be accompanied by secondary immunological complications, such as arthritis and erythema nodosum. Severe outbreaks of foodborne infections in North America have been caused by O:8 strains. Cases of human infection with Y. enterocolitica in Australia, Central Europe and North America have surpassed shigella and now rank in third place, after salmonellosis and campylobacteriosis, in the list of infectious diseases (8, 18).

Cases of yersiniosis have been known in several warm-blooded animals, but Yersiniae have mostly been isolated from inapparently infected slaughter animals (Table I). In praxis, problems with the serological detection of yersiniosis may exist. Cross-reaction between the serovar O:9 of Y. enterocolitica and Brucella abortus are known (38).

Y. pseudotuberculosis can be isolated from cases of human enteritis which are similar to Y. enterocolitica infections. Neither infection can be clinically differentiated in humans. Y. pseudotuberculosis has also been isolated from inapparently infected slaughter animals. Pseudotuberculosis is well-known in warm-blooded animals. Y. ruckeri has been isolated from ulcerative alterations of freshwater fish (8).
Although *Y. pestis* can be re-isolated from experimentally-infected but apparently healthy pigs (15), there is no evidence that pathogenic *Y. pestis* strains affect slaughter animals or effluents from the food industry.

Pathogenic strains of *Yersinia* harbour a 40-50 megadalton virulence plasmid, which is necessary — though not sufficient in itself — to express virulence (31). An invasive outer membrane protein was found in *Y. enterocolitica* and, similarly, in *Y. pseudotuberculosis*, mediating orally-based infections (43).

Strains bearing plasmid-encoded virulence factors can be ascertained by different and fairly simple methods: calcium dependency (27), autoagglutination (32), Congo red binding (44) and pyrazinamidase activity (28). *In vitro* growth at 37°C leads to the loss of virulence plasmid.

### Table I

*Serovars, biovars, sources and distribution of human pathogenetic strains of Yersinia enterocolitica* (8)

<table>
<thead>
<tr>
<th>O-antigens</th>
<th>H-antigens</th>
<th>Biovars</th>
<th>Sources</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2a, 3</td>
<td>a, b, c</td>
<td>3</td>
<td>Chinchillas</td>
<td>Europe, USA</td>
</tr>
<tr>
<td>2a, 2b, 3</td>
<td>b, c</td>
<td>5</td>
<td>Hares, goats, rabbits, monkeys</td>
<td>Europe</td>
</tr>
<tr>
<td>3</td>
<td>a, b, c</td>
<td>4</td>
<td>Man, swine, dogs, cats, rats</td>
<td>Europe, South Africa, Canada, Japan, USA, South America, Australia</td>
</tr>
<tr>
<td></td>
<td>a, b, c, v</td>
<td></td>
<td></td>
<td>Germany, Norway</td>
</tr>
<tr>
<td></td>
<td>a, c</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c</td>
<td>4</td>
<td>Man, swine, poultry, meat</td>
<td></td>
</tr>
<tr>
<td>4, 32</td>
<td>b, e, f, i</td>
<td>1B</td>
<td>Man, food</td>
<td>USA</td>
</tr>
<tr>
<td>5, 27</td>
<td>a, b, c</td>
<td>2 or 3</td>
<td>Man, dogs, monkeys Wild animals, milk</td>
<td>Germany, Netherlands</td>
</tr>
<tr>
<td></td>
<td>b, c</td>
<td>2 or 3</td>
<td>Milk products, surface waters</td>
<td>USA, Canada, Japan, Australia</td>
</tr>
<tr>
<td>8</td>
<td>b, e, f, i</td>
<td>1B</td>
<td>Man, swine, milk, milk products, drinking water</td>
<td>USA</td>
</tr>
<tr>
<td></td>
<td>b, e, f, i, v</td>
<td></td>
<td></td>
<td>Canada, (Italy), (Netherlands)</td>
</tr>
<tr>
<td>9</td>
<td>a, b</td>
<td>2 (3)</td>
<td>Man, swine, dogs, cats, rats</td>
<td>Europe</td>
</tr>
<tr>
<td></td>
<td>a, b, c</td>
<td></td>
<td></td>
<td>Japan</td>
</tr>
<tr>
<td></td>
<td>a, b, c, v</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a, c</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13a, 13b</td>
<td>a, b, i</td>
<td>1B</td>
<td>Man, monkeys, milk</td>
<td>USA</td>
</tr>
<tr>
<td>18</td>
<td>b, e, f, i</td>
<td>1B</td>
<td>Man</td>
<td>USA</td>
</tr>
<tr>
<td>20</td>
<td>b, e, f, i</td>
<td>1B</td>
<td>Man, dogs, rats</td>
<td>USA</td>
</tr>
<tr>
<td>21</td>
<td>b, e, f, i</td>
<td>1B</td>
<td>Man, strain &quot;Tacoma&quot;</td>
<td>USA</td>
</tr>
</tbody>
</table>

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Yersiniae are widely distributed in the environment. Apathogenic strains are most frequently isolated from surface waters as far as the northern subalpine regions (30). The widespread occurrence in wild animals (e.g., small rodents, foxes, birds) reflects the ability of Yersiniae to persist for long periods in the environment as reservoirs for the wildlife population.

Pathogenic strains of Yersiniae grow under the same conditions as the apathogenic strains; strains of Y. enterocolitica, belonging to serogroups O:3, O:8 and O:9, have been recorded in waters either at very low frequencies or not at all (33).

Although numerous investigations have revealed the possible carriers of Yersiniae and the means of transmitting Yersinia infections, the influence of the main carrier of Yersiniae (swine, for example) on the environment by effluents from food-processing plants has not hitherto been fully clarified. One hopes the present paper will contribute to this epidemiologically important aspect.

YERSINIA IN FOOD-PROCESSING INDUSTRIES

The food-processing industry may influence the epidemiological situation in the environment throughout the production line. Effluents which contaminate the environment may originate from slaughterhouses; e.g., sewage contaminated with faeces from the lairage and contaminated effluents from the actual slaughter areas. The carcasses serve as possible carriers of the organisms to the food-processing plants where they may eventually contaminate the processed foods. Rodents and pests are other possible carriers to food-processing plants. These carriers may also play a role as reservoirs for contamination of both the processing line and the products.

Slaughterhouses

Most isolates of pathogenic Yersiniae, Y. enterocolitica and Y. pseudotuberculosis, have been recorded in different percentages of healthy swine throughout the world. In Europe, isolates from slaughter swine have been reported from Scandinavia to Bulgaria. In Norway, isolation rates of Y. enterocolitica O:3, biovar 4, were recorded up to 83% from oral cavities and 27% from circumanal incisions. Cell counts on the surfaces of tongues and tonsils reached $1.8 \times 10^2$/cm$^2$ and $1.7 \times 10^3$/cm$^2$, respectively (40). In Finland, up to 35.7% of swine tonsils bore these pathogenic Y. enterocolitica during autumn and winter (10). Pathogenic Y. enterocolitica were also found in Danish swine herds with isolation rates of up to 49% from tonsils and 17.7% from faeces (16).

The isolation rates from tonsils showed a mediate seasonal correlation. From April to December, isolations were positive for Y. enterocolitica O:3 and O:9, but higher percentages were found during winter months (17.5% in November, 32.5% in December) (64). Stronger seasonal correlations were detectable from faeces in German investigations. Pathogenic serovars could be isolated from October to December in only 7.8% of samples (14). In another survey, isolations of Y. enterocolitica O:3 and O:9 from faeces were made from September to April and reached maximal rates of 12.6% (63).
Y. enterocolitica O:3, biovar 4, was reported in 24.7% of rectum samples investigated in the Netherlands (9). Y. enterocolitica of the serogroups O:3 and O:9 could also be found in southeastern Europe; in Bulgaria, 55% of the tonsils of slaughter swine were positive (50).

In Japan, Y. enterocolitica also showed seasonal occurrence in slaughter swine, primarily from October to March (58). The maximal isolation rate of human pathogenic strains O:3 and O:5 from caecal content was 4.6% in November. In another investigation in Japan, the pathogenic serovars O:5,27 and O:3 were found simultaneously (65).

A study in Canada from October to March led to 12.5% isolation rates of Y. enterocolitica O:3, biovar 4, from the faeces of slaughter swine (36).

Pathogenic strains of Y. enterocolitica O:8 were isolated from swine tongues at a rate of 19.4% in an investigation in the United States, where O:3 is also common. The phage types of O:3 strains in North America (IXb) are different from the European or the Japanese strains (VIII) (19).

Only occasionally have human pathogenic strains of Y. enterocolitica been isolated from apparently healthy slaughter animals other than swine. Pathogenic serovars have been exceptions: Y. enterocolitica O:9 was isolated in 6.8% of cattle-faeces samples in a survey in Germany (26). In Hungary, Y. enterocolitica O:3 was isolated only once in cattle (55). In another investigation of cattle in Germany, 10% of the animals under study showed specific agglutinin titres against O:8 following abortion, and 4.4% showed titres against O:3 (cultivable O:8 strains in this study belonged to O:7,8) (39).

Y. enterocolitica O:3, biovar 4, could only be found at a rate of less than 1% in isolations from slaughter sheep (35). Isolations from faeces, though not from tonsils, were possible in this study. Y. enterocolitica O:5 strains were isolated from sheep abortion material; in one case, a O:8 strain of Y. enterocolitica was also isolated (39).

Healthy poultry are known to bear apathogenic strains of Y. enterocolitica (17). The detection of Y. enterocolitica O:3 and O:9 in dead poultry was reported in 9.8% of the cases studied (39).

Y. pseudotuberculosis, accompanied by Y. enterocolitica, has been found in apparently healthy swine throughout the world. This occurrence has a seasonal influence, similar to that of Y. enterocolitica (64). In a study in Germany, Y. pseudotuberculosis (O-groups I, II and III) was detectable during winter and spring only, while Y. enterocolitica was also isolated in autumn (63). O-group III was reported in Japan (59) and Canada (57). In the latter two studies, detection of Y. pseudotuberculosis was also possible in autumn.

Numerous investigations have shown that Yersiniae can be isolated not only from slaughter animals but also from different places in the slaughterhouse environment. Y. enterocolitica O:3, biovar 4, has been found in samples from the floor of the bleeding area, the eviscerating area and from the viscera table; only minor cell counts of pathogenic Y. enterocolitica have also been detected in the meat inspection area (40). In another survey, samples from the slaughter floor and the scalding tank water were negative, but samples from the cold room led to the isolation of Y. enterocolitica O:7,8 (36). Infections of swine in pens which had been contaminated by a previous group of swine were reported from Japan, where Y. enterocolitica O:3, biovar 4, survived in faeces for two to seven weeks (22).
Modifications of the slaughter process have shown that the liberation of pathogens into the slaughterhouse environment can be reduced. Recommendations have been given to avoid contact of tools and hands with the highly contaminated tonsillary region of swine. Techniques to reduce the distribution of pathogenic *Yersinia* include the complete or partial removal of the head (e.g., the tongue and pharynx) as an early operation (40), the use of a mechanised bung cutter and methods to avoid contact with the anal region (enclosing the anus and rectum in a plastic bag, for example) (9).

Pathogenic *Y. enterocolitica* and *Y. pseudotuberculosis* strains occur mainly in swine and pork. Swine are obviously able to bear human pathogenic *Y. enterocolitica* strains, particularly 0:3, biovar 4, without signs of illness. As other slaughter animals may either exhibit signs of disease or resist infections, findings in these animals at slaughterhouses are rare.

The principal source of contamination at slaughtering seems to be offal, such as tonsils, rather than swine faeces. In many investigations, pathogenic *Yersinia* have been isolated three to four times more frequently from tonsils than from faeces (57, 58, 64, 65). Careful handling and closed storage of removed offal before adequate heat treatment can therefore minimise the risk from pathogenic effluents.

**Other food-processing industries**

Contamination levels of food-processing industries which produce foods of animal origin depend on the contamination level of raw materials and the general hygiene of the plant. Food workers infected with pathogenic strains of *Y. enterocolitica* and *Y. pseudotuberculosis* may also be carriers. The hygiene status of a plant should include protective mechanisms against pests; in many countries, however, flies (and sometimes rats) are not uncommon in areas near food-processing plants.

The contamination of meat as a raw material for food production results from the above-mentioned infections of swine and other animals. Different investigations have shown that *Y. enterocolitica* O:3, biovar 4, can be isolated from the surfaces of freshly slaughtered carcasses. After manual evisceration, surface examinations were carried out on a group of swine, 24.7% of which were faeces-positive; *Y. enterocolitica* was found on the medial hind limb in 26.3% of these cases and on 12.9% of split sternae (9). Pathogenic *Y. enterocolitica* was isolated from cut surfaces of swine with oral cavities positive in 83.3% of the cases; at slaughter, *Y. enterocolitica* was isolated from 46.7% of the cranial incisions and 43.3% of the abdominal incisions (40). In another survey, 2.5% of pork samples bore *Y. enterocolitica* O:3, biovar 4, in cell counts of up to $10^3$ cfu/g (25).

Although *Y. enterocolitica* is not normally harboured by dairy cows, raw milk often contains strains which are predominantly apathogenic (37, 48). However, a O:8 strain was isolated in the United States from an outbreak of illness caused by chocolate milk (13). In a Canadian study, different apathogenic *Y. enterocolitica* strains could be detected from raw milk and cheese curd; after four weeks of aging, one of seven cheeses was still positive (47). In France, *Y. enterocolitica* O:5,27 was isolated in 5.3% of raw milk samples examined in a survey (60). A foodborne gastroenteritis outbreak caused by raw milk contaminated with *Y. enterocolitica* O:5,27 was also reported from Canada (52).
Low contamination rates of pathogenic *Yersiniae* have also been reported from poultry. Examinations of 82 samples from different slaughter lines revealed only two positive samples (O:5,27 and O:8) (42). *Yersiniae* have been isolated from raw egg matter in egg breaking plants (54). More recently, investigations have concluded that poultry are seldom a source of *Y. enterocolitica* infections (17, 25).

*Yersiniae* have also been isolated from fish (34). In Alaska, pathogenic *Y. enterocolitica* strains were found in edible crabs (20).

Pathogenic *Yersiniae* have been isolated from different food sources. The ability to multiply under refrigeration and in vacuum-packaged products means that pathogenic *Y. enterocolitica* may cause foodborne diseases in many forms of modern packaged and refrigerated foods (52, 53).

The most important “effluent” of food-processing plants, and the one with the greatest potential for contamination, is the food product itself. Provided other wastes, such as those from meat production and cheese processing, are disposed of hygienically, the usual effluents from food-processing plants (other than slaughterhouses) are wastewaters from the production area. Pests and rats infected by contaminated sewage should also be considered as “effluents” in the epidemiological sense.

### YERSINIAE IN EFFLUENTS OF FOOD-PROCESSING INDUSTRIES

*Yersiniae* are able to survive in water and the environment at cool temperatures. If a plant harbours any pathogenic strain of *Yersiniae*, it is possible for the contaminant to be transferred to the sewage. Depending on the elimination procedures used in the processing of sewage, *Yersiniae* may be transported to environmental waters.

Most of the *Yersinia* strains found in sewage and environmental waters are apathogenic (7, 12, 33, 45, 46, 51). Pathogenic strains could be isolated from the environment only in some studies. In Japan, for example, *Y. enterocolitica* O:3 could be detected in river water samples downstream from a piggery where *Y. enterocolitica* O:3-positive swine were found (23). During this survey, most apathogenic strains of *Y. enterocolitica* O:9 were isolated from waters with unknown sources of contamination. Only one strain out of 644 *Yersiniae* isolated from a sewage treatment plant could be determined as *Y. enterocolitica* O:9 as a result of one of the first clarification steps (46). No strains of pathogenic serovars were found in the final effluent of this plant.

Three isolates of *Y. enterocolitica* O:3, but not of biovar 4, were detected in 779 samples (49) from a drinking-water plant in Germany. Pathogenic serovars of *Yersiniae* were also absent in a comparable investigation also in Germany (7).

Contamination with O:8 in a mountain stream in the United States was probably caused by infected animals (52). Pathogenic *Y. enterocolitica* strains were found in marine crabs collected near Kodiak (Alaska), but not at sites far removed from human settlements (20).
A different situation has been reported regarding animals, such as rats, which live in sewers and drains. *Y. enterocolitica* O:3 was isolated from rats in 16.3% of pig houses investigated in Czechoslovakia (2). *Y. pseudotuberculosis* O-group III was also detected in certain of these study cases in the same area. In another study, rats from slaughterhouses harboured *Y. pseudotuberculosis* O-group I in the same manner as had the slaughtered swine (4). In Japan, the following pathogenic *Y. enterocolitica* serovars were isolated from slaughterhouse rats: O:3, biovar 4 (2 out of 24 cases) (29) and O:9 (1 out of 165 cases) (65). Rats from areas other than those mentioned above were predominately infected with apathogenic *Y. enterocolitica* strains (2, 3, 29).

Other pests, such as flies, may also act as carriers of pathogenic *Yersinia*. *Y. enterocolitica* O:3, biovar 4, has been isolated from flies from an area near a piggery (21).

The discovery of predominately apathogenic *Yersinia* in sewage and water may reflect differences in the capacity of the serovars to survive. *Yersinia* in sewage have been found to survive for as long as 18 months. The isolation of strains of *Y. enterocolitica* was only possible in sewage sludge stored from one to three months (33); after three months, the only *Yersinia* recorded belonged to other species. The length of time which *Y. enterocolitica* can survive in sewage seems to be three times shorter than that of other *Yersinia*. When water-specific apathogenic strains already occur, a competitive effect may play a role in water. Such strains are even found in well-water and in drinking-water (7).

A *Yersinia* reduction rate of more than 99% was obtained in a sewage treatment plant when a 5-step technique, including a bacteriologically-activated sludge step, was used (46).

In many countries, sewage flows into surface waters without first being clarified by treatment plants. When surface waters or sewage water are used for irrigation, pathogenic bacteria may contaminate the soil and crops. According to at least one study, enterobacteriaceae have been isolated 135 cm beneath the soil surface after irrigation with sewage water; however, no *Yersinia* could be found (1).

Although pathogenic *Yersinia* from infected animals are able to survive in sewage and in surface waters, the role of properly treated sewage in the transmission of yersiniosis seems to be of little concern; modern sewage treatment techniques sufficiently reduce pathogenic *Yersinia*.

Far greater epidemiological concern exists with regard to animal carriers from piggeries, slaughterhouses and other places where pathogens occur. Such carriers can infect neighbouring farms directly by contact or through contamination of feeds. They also act as reservoirs for the contamination of processed foods.

Isolation of pathogenic *Yersinia* from marine animals in waters near human settlements illustrates that very low contamination rates, not detectable in water by usual methods, can nevertheless be of epidemiological concern.

All plants which produce foods of animal origin should hinder both the flow of untreated sewage into the environment and the breeding of rats and pests on their premises. Several publications have shown ways to reduce the liberation of pathogenic *Yersinia* during the slaughter process. If such recommendations are properly followed, the distribution of pathogens in the slaughterhouse environment and,
subsequently, into other food-processing plants, can be reduced. At the same time, the risks of transmitting human pathogenic *Y. enterocolitica* strains into foods, sewage and other effluents can also be minimised.

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**YERSINIA DANS LES EFFLUENTS DES INDUSTRIES DE TRANSFORMATION DE PRODUITS ALIMENTAIRES.** – M. Hartung et K. Gerigk.

Résumé: *Yersinia enterocolitica* et *Yersinia pseudotuberculosis* sont à l'origine de souches pathogènes chez l'homme et chez l'animal. Les infections par Yersinia sont cosmopolites mais sont plus fréquentes sous les climats tempérés et subtropicaux. Les cas d'infection par *Yersinia enterocolitica* occupent actuellement le troisième rang en Australie, en Europe centrale et en Amérique du Nord. Le rôle des industries agro-alimentaires dans l'épidémiologie peut s'exercer de diverses façons. Les effluents des abattoirs peuvent provoquer la contamination de l'environnement, les eaux usées pouvant notamment être contaminées à partir des locaux de stabulation ou à partir des zones d'abattage proprement dites. Les carcasses peuvent véhiculer les micro-organismes jusqu'aux usines de transformation, où elles contaminent éventuellement les produits préparés. Les rongeurs et autres nuisibles sont également des porteurs possibles.

Les porcs et leur viande sont les principaux réservoirs de souches pathogènes de *Y. enterocolitica* et de *Y. pseudotuberculosis*. Le froid et l'emballage sous vide permettent à *Y. enterocolitica* de se multiplier, ce qui rend cet agent responsable de toxi-infections alimentaires. Si des *Yersinia* pathogènes sont présents dans une usine, ils peuvent contaminer les eaux usées. Bien que les *Yersinia* pathogènes éliminés par des animaux infectés puissent survivre dans les eaux usées et les eaux superficielles, un traitement adéquat de ces eaux réduit leur rôle dans la transmission de la yersiniose. Si les recommandations propres aux techniques modernes d'abattage sont correctement appliquées, la propagation de ces organismes pathogènes dans les abattoirs et, par voie de conséquence, dans les autres établissements de transformation, peut être minimisée.


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**YERSINIA EN LOS EFLUENTES DE LAS PLANTAS DE TRANSFORMACIÓN DE ALIMENTOS.** – M. Hartung y K. Gerigk.

**Resumen:** *Yersinia enterocolitica* y *Yersinia pseudotuberculosis* se encuentran al origen de ciertas cepas patógenas en el hombre y en los animales. Las infecciones por Yersinia son cosmopolitas, pero son más frecuentes en las zonas templada y subtropical. En Australia, Europa Central y América del Norte, los casos de infección por *Y. enterocolitica* ocupan actualmente el tercer grado de importancia. El papel desempeñado por las industrias agroalimentarias en la situación epidemiológica se ejerce de varias maneras. Los efluentes de los mataderos que pueden contaminar el medio ambiente provienen en particular
de los locales de estabulación contaminados por las heces de los animales, así como de los de matanza. Las carnes pueden igualmente vehiculrar los microorganismos en las plantas de transformación y contaminar los productos procesados. Los roedores y los insectos dañosos pueden igualmente ser portadores.

Los cerdos y su carne son los principales huéspedes de las cepas patógenas de Y. enterocolitica y de Y. pseudotuberculosis. Y. enterocolitica se multiplica a temperaturas de refrigeración y dentro de embalajes en vacío, y puede causar toxi-infecciones alimentarias. Los Yersinia patógenas presentes en una planta industrial pueden contaminar sus aguas residuales. A pesar de que los Yersinia patógenos eliminados por animales infectados sobrevivan en las aguas residuales y de superficie, el papel desempeñado por estas aguas en la transmisión de la yersiniosis puede reducirse cuando éstas son correctamente tratadas. Si se aplican las recomendaciones sanitarias propias a las técnicas modernas en los mataderos, se puede minimizar la propagación de los organismos patógenos en los mismos, y por consecuente, en las demás industrias de transformación de alimentos.


REFERENCES


