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Arcobacter: An Overview

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Introduction

The genus Arcobacter (Latin, arc-shaped bacterium) includes bacteria formerly designated Campylobacter cryaerophilus (Latin; loving cold and air). They are fastidious, microaerophilic, gram-negative, spiral-shaped bacteria that are motile by means of polar flagella. Arcobacter was first isolated by Ellis et al (6) in 1977 from aborted bovine and later from porcine fetuses. Unlike other Campylobacter species, Arcobacter grows in the presence of atmospheric oxygen (aerotolerant) and at 15°C, which is lower than temperatures used for incubation of Campylobacter (21,22).

Arcobacter spp. have been associated with cases of human enteritis and septicemia (12, 13, 27, 28, 29,30); enteritis and abortion occur in livestock (6,21,22,23,24). Arcobacter spp. have been found in water, cattle, swine, poultry, and in ground pork and turkey products. Campylobacter jejuni is a major cause of human bacterial enteritis. Because of their phylogenetic similarity, the pathogenesis, distribution and routes of transmission that have been described for C. jejuni may be applicable to Arcobacter. Transmission of C. jejuni to humans occurs via consumption of contaminated undercooked poultry, water, raw milk, milk that has been contaminated after pasteurization, shellfish, and meat.

Three species of Arcobacter have been recovered from man and animals: A. butzleri, A. cryaerophilus, and A. skirrowii (31,32). Of these, A. butzleri is regarded as the primary human pathogen (12).

Herein we provide a review of Arcobacter and address the possibility of considering Arcobacter spp., especially A. butzleri, as emerging foodborne pathogens.

Results and Discussion

Figure 1 summarizes the current knowledge regarding the prevalence of Arcobacter in food animals and in foods. Infections in humans and animals. Arcobacter infections in animals are associated with abortions and enteritis (37). Enteritis and occasionally septicemia occur in humans (13, 27, 28, 30). Primates naturally infected with Arcobacter develop colitis, which may provide insight into its pathogenesis in humans (1).

For cattle, Arcobacter spp. have been reported in the feces of calves with diarrhea, cows with mastitis (15), as well as from clinically healthy animals. We have developed a rapid method to detect Arcobacter, which involves enrichment in Ellinghausen McCullough, Johnson, and Harris (EMJH-P80) semisolid media, incubation (30°C, 1 week), followed by polymerase chain reaction (PCR) screening (10). Using this method, we detected Arcobacter in 11% of fecal samples from normal dairy cattle (n=1,236).

Arcobacter is present in both healthy pigs and in aborted porcine fetuses (7, 22, 23,37). We have cultured significantly more (P<0.001) Arcobacter from aborted porcine fetuses than from fetuses obtained from a slaughterhouse. Despite the association of Arcobacter with porcine abortions, no differences were seen in the recovery of Arcobacter spp. from rectal, preputial, or vaginal swabs taken from pigs from a herd with reproductive problems versus a herd of specific pathogen-free animals. By enrichment in EMJH-P80 followed by PCR, we detected Arcobacter spp. in 40% of fecal samples of clinically healthy pigs. We have experimentally infected caesarean-derived colostrum-deprived piglets with Arcobacter spp. and have shown that A. butzleri, like C. jejuni and colonizes neonatal piglets. This suggests its invasive potential (36). In vitro studies using HEp-2 cells likewise have indicated its potential virulence (9).

Detection in foods-In beef products, Arcobacter spp. have been cultured in 1. 5% of minced beef (n=68) samples examined in The Netherlands (5). No studies to date have reported the distribution of Arcobacter in fresh ground beef in the U.S.

Its recovery in hogs and susceptibility of piglets to infection suggest a possible association of Arcobacter spp. with pork products. Collins et al. (3) detected Arcobacter in 54% of ground pork samples (n=289) obtained from five slaughter plants. Recoveries ranged from 0% to 89%. It was not determined whether management practices at the source farms or the sanitary conditions at slaughter influenced the prevalence of Arcobacter spp. in ground pork. However, using an Arcobacter Selective Broth and Medium, deBoer et al., isolated the organism in only 0.5% (1 of 194) of pork cuts purchased in the Netherlands (5). The difference between ground pork and minimally processed pork cuts as well as isolation methods may explain these differences. Arcobacter, like Campylobacter, has been reported more frequently from poultry than from red meats (34). Thus, poultry may be a significant reservoir of A. butzleri. In France, A. butzleri was recovered from 81% of poultry carcasses examined (n=201). Nearly half of the poultry isolates in that study were of serogroup 1. Serogroups 1 and 5 are primarily associated with human infection (8,18). In a survey of poultry products in Canada, A. butzleri was cultured from 97% (121 of 125) of poultry carcasses obtained from five different processing plants. In addition, A. butzleri was cultured from retail-purchased whole and ground chicken and turkey samples. As was the case in the French study, serotype 1 was the predominant serotype isolated from Canadian poultry (17). We utilized EMJH-P80 enrichment in combination with PCR11 to determine the prevalence of Arcobacter in mechanically separated turkey samples obtained from three processing plants in the U.S. Of 395 samples examined, 77% (303 of 395) were positive for Arcobacter. Arcobacter butzleri was detected in 56% of samples (223 of 395) (19). In contrast to the recoveries from poultry which were reported from France, Canada, and the U.S., Arcobacter was detected in only 24% (53 of 224) of...
retail purchased poultry in the Netherlands (5). The differences in recovery rates could be due to hygienic conditions in each abattoir or processing plant, as well as to differences in the sensitivity of isolation methods. Despite repeated attempts, we have not established Arcobacter experimental infections in 3-day-old chicks. Nevertheless, on-farm studies to determine the carrier rate of poultry are needed.

The distribution of Arcobacter spp. in seafoods, shellfish, and raw milk is unknown. The presence of A. butzleri in poultry and meats, especially ground pork, prompted studies to determine its sensitivity to irradiation (4). By comparing D_{10} values (the irradiation dose that reduces by 10-fold the number of viable bacteria), A. butzleri (0.27 kGy) was found to be more resistant to irradiation than C. jejuni (0.18 kGy). Thus, proposed irradiation doses (1.5 to 4.5 kGy), which are under review by the U. S. Food and Drug Administration, would eliminate Campylobacter as well as Arcobacter from ground pork (4).

Transmission of A. butzleri may involve drinking contaminated water (8,16). Arcobacter spp. may be more common in developing nations with inadequate water supplies since A. butzleri accounted for 16% of the Campylobacter-like isolates made from cases of diarrhea in Thai children (28). Arcobacter butzleri has been cultured from rivers (20), canals of Bangkok (34), and drinking water reservoirs in Germany (16).

Isolation methods and species identification. The morphologic similarity between Arcobacter and Campylobacter may confound correct identification. A key feature to distinguish Arcobacter spp. from other Campylobacter spp. is the lower temperatures (15°C-30°C) which are utilized for initial isolation (22). Whereas C. jejuni, C. coli, or C. lari grow optimally at 42°C, few Arcobacter display this thermotolerance.

There is no standard method for the isolation of Arcobacter spp., which restricts comparison of field studies. Arcobacter spp. were first isolated by using EMHJ-P80 semi solid media originally designed for Leptospira (22). Modifications of methods defined for Campylobacter, but at lower incubation temperatures also have been used (17). A comparison of each method’s sensitivity is needed. Biochemical tests to phenotype Arcobacter species are limited (13, 21, 25, 26, 32). All isolates hydrolyze indoxyl acetate. The catalase test can distinguish between the two species of clinical and veterinary interest: A. butzleri exhibits a weak catalase reaction whereas that of A. cyaerophilus is strong (13, 32).

The species of Arcobacter are distinguished by restriction fragment length polymorphisms (ribotyping). For ribotyping, chromosomal DNA is extracted, cut with a restriction enzyme, and hybridized with 16S rDNA probes. The resultant DNA pattern or ribotype of A. butzleri differs from that of A. cyaerophilus and thus can be used for speciation (14, 26, 35).

PCR assays to detect all members of the genus Arcobacter (10) and that are specific for each Arcobacter species have been reported (2). A multiplex PCR assay to simultaneously identify Arcobacter and A. butzleri in livestock and foods has been described (11). DNA-based fingerprinting may provide insight into the source of Arcobacter contamination. In a 1993 study, PCR-mediated DNA fingerprinting confirmed the identity of A. butzleri isolates recovered from a nursery school outbreak, suggested person-to-person transmission, and implicated a single source of contamination (33). In contrast, we used DNA probes and PCR fingerprinting to study over 121 A. butzleri field strains recovered from mechanically separated turkey meat. The presence of multiple fingerprints indicated numerous sources of contamination (19).

Conclusion

Arcobacter spp. are found in livestock, meat, and in water. As summarized in Figure 1, Arcobacter spp. have been described in cattle and beef, and in pigs and pork products. Although they have been recovered from poultry, the incidence of Arcobacter spp. in live birds is unknown. Earlier reports described A. skirrowii in lambs, but whether it is present in lamb products is unknown. The current availability of DNA-based methods will further contribute to understanding the basic epidemiology of A. butzleri and thus elucidate its potential as a human foodborne agent.

References


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Figure 1. Summary of distribution of *Arcobacter* in livestock species and the respective food product. A (+) indicates that *Arcobacter* has been recovered from live hogs, and cattle as well as from retail purchased pork and poultry. A (?) indicates insufficient data available to determine the distribution of *Arcobacter* in live poultry, and retail purchased beef or lamb products.