Presence of *Campylobacter* and *Arcobacter* species in in-line milk filters of farms authorized to produce and sell raw milk and of a water buffalo dairy farm in Italy

A. Serraino,1 D. Florio, F. Giacometti, S. Piva, D. Mion, and R. G. Zanoni

Department of Veterinary Medical Sciences, via Tolara di Sopra 50, 40064 Ozzano Emilia, Bologna, Italy

**ABSTRACT**

The objectives of this study were to investigate the presence of *Campylobacter* spp. and *Arcobacter* spp. in dairy herds authorized for the production and sale of raw milk and in a water buffalo dairy farm, and to test the antimicrobial susceptibility of the isolates. A total of 196 in-line milk filters were collected from 14 dairy farms (13 bovine and 1 water buffalo) for detection of *Campylobacter* spp. and *Arcobacter* spp. by microbiological culture. For each farm investigated, 1 isolate for each *Campylobacter* and *Arcobacter* species isolated was tested using the Etest method (AB Biodisk, Solna, Sweden) to evaluate the susceptibility to ciprofloxacin, tetracycline, chloramphenicol, ampicillin, erythromycin, and gentamicin. A total of 52 isolates were detected in 49 milk filters in 12 farms (85.7%) out of 14 and the isolates were identified as *Campylobacter jejuni* (8), *Campylobacter hyointestinalis* spp. *hyointestinalis* (8), *Campylobacter concisus* (1), *Campylobacter fetus* spp. *fetus* (1), *Arcobacter butzleri* (22), and *Arcobacter cryaerophilus* (14). The small number of isolates tested for antimicrobial susceptibility precludes any epidemiological consideration but highlights that all *Campylobacter* isolates were susceptible to macrolides, which are the first-choice drugs for the treatment of campylobacteriosis, and that resistance to fluoroquinolones and tetracycline was detected; for *Arcobacter* isolates, resistance to ampicillin and chloramphenicol was detected. The sale of raw milk for human consumption by self-service automatic vending machines has been allowed in Italy since 2004. Dairy farms are major reservoirs of foodborne pathogens (Oliver et al., 2009) and unpasteurized milk consumption has been implicated as a major risk factor for *Campylobacter jejuni* human infection (Studahl and Andersson, 2000; Neimann et al., 2003; Nachamkin, 2007) even in Italy (Giacometti et al., 2012a,b) where several outbreaks have been reported (Amato et al., 2007; Arrigoni et al., 2009). In our previous study on the presence of foodborne pathogens in in-line milk filters of dairy farms authorized to produce and sell raw milk in Italy (Giacometti et al., 2012c), we isolated, during analysis for thermotolerant *Campylobacter*, 6 other thermophilic campylobacters including *Campylobacter hyointestinalis* spp. *hyointestinalis* and *Campylobacter sputorum* biovar *sputorum*. This observation suggested that extraordinary and nonstandardized growth conditions were needed to recover non-*jejuni/coli* *Campylobacter* spp. and other *Campylobacter*-like microorganisms, namely *Arcobacter* spp. to provide more information and data on those poorly known emergent zoonotic pathogens. Human infection caused by non-*jejuni/coli* *Campylobacter* spp. has been reported in the literature (Man, 2011) and *Arcobacter* spp. have been associated with gastroenteritis in humans and occasionally with bacteremia (Collado and Figueras, 2011). The presence of non-*jejuni/coli* *Campylobacter* spp. and *Arcobacter* spp. has been reported in cattle (Kabeya et al., 2003; Van Driessche et al., 2005; Oporto et al., 2007; Vilar et al., 2010) and in milk (Scullion et al., 2006; Pianta et al., 2007; Ertas et al., 2010; Shah et al., 2012).

The consumption of raw contaminated food of animal origin was hypothesized as a route of transmission of both *Campylobacter* spp. (Man, 2011) and *Arcobacter* spp. (Van Driessche et al., 2005) to humans.

**Key words:** *Campylobacter* spp., *Arcobacter* spp., raw milk, milk filter

**INTRODUCTION**

The sale of raw milk for human consumption by self-service automatic vending machines has been allowed in Italy since 2004. Dairy farms are major reservoirs of foodborne pathogens (Oliver et al., 2009) and unpasteurized milk consumption has been implicated as a major risk factor for *Campylobacter jejuni* human infection (Studahl and Andersson, 2000; Neimann et al., 2003; Nachamkin, 2007) even in Italy (Giacometti et al., 2012a,b) where several outbreaks have been reported (Amato et al., 2007; Arrigoni et al., 2009). In our previous study on the presence of foodborne pathogens in in-line milk filters of dairy farms authorized to produce and sell raw milk in Italy (Giacometti et al., 2012c), we isolated, during analysis for thermotolerant *Campylobacter*, 6 other thermophilic campylobacters including *Campylobacter hyointestinalis* spp. *hyointestinalis* and *Campylobacter sputorum* biovar *sputorum*. This observation suggested that extraordinary and nonstandardized growth conditions were needed to recover non-*jejuni/coli* *Campylobacter* spp. and other *Campylobacter*-like microorganisms, namely *Arcobacter* spp. to provide more information and data on those poorly known emergent zoonotic pathogens. Human infection caused by non-*jejuni/coli* *Campylobacter* spp. has been reported in the literature (Man, 2011) and *Arcobacter* spp. have been associated with gastroenteritis in humans and occasionally with bacteremia (Collado and Figueras, 2011). The presence of non-*jejuni/coli* *Campylobacter* spp. and *Arcobacter* spp. has been reported in cattle (Kabeya et al., 2003; Van Driessche et al., 2005; Oporto et al., 2007; Vilar et al., 2010) and in milk (Scullion et al., 2006; Pianta et al., 2007; Ertas et al., 2010; Shah et al., 2012).

The consumption of raw contaminated food of animal origin was hypothesized as a route of transmission of both *Campylobacter* spp. (Man, 2011) and *Arcobacter* spp. (Van Driessche et al., 2005) to humans.
Although most cases of gastroenteritis caused by Campylobacter spp. and Arcobacter spp. infections are self-limited and do not require treatment, antimicrobial therapy is indicated in the case of severe and prolonged gastroenteritis and for immune-suppressed patients (Hakkinen et al., 2007) and the increasing evidence of strains of animal origin resistant to tetracycline and fluoroquinolones is recognized as an emerging public health problem (Lévesque et al., 2007).

The utility of testing in-line milk filters as a sensitive way to detect pathogens in dairy herds is well documented and an index of a potential and probable raw milk contamination (Warnick et al., 2003; Van Kessel et al., 2011); hitherto, only 2 studies have investigated the presence of C. jejuni in milk filters (Leone et al., 2010; Giacometti et al., 2012c) and no data were on presence of non-jejuni/coli Campylobacter spp. and Arcobacter spp. in milk filters of dairy farms.

The objectives of the present study were to investigate the presence of Campylobacter spp. and Arcobacter spp. in in-line milk filters in herds authorized for the production and sale of raw milk in Northern Italy and to test the susceptibility to antimicrobial agents of Campylobacter spp. and Arcobacter spp. isolates to deepen the evaluation of the potential risks linked with raw milk consumption. In addition, a dairy water buffalo farm producing water buffalo Mozzarella cheese made with raw milk was included in the study.

**MATERIALS AND METHODS**

**Sampling and Sample Collection**

All 33 farms were authorized for production and sale of raw cow milk and only 1 water buffalo dairy farm in the province of Bologna (Emilia-Romagna Region, Italy) were taken into account; after a visit to each farm, a personal letter was delivered to farmers inviting them to participate in this study. A total of 32 farmers replied, 2 farmers did not reply at all, and 18 farmers declined to participate. Consequently, with the 14 farmers’ consent, a total of 14 farms located in the province were included in the study: 13 farms that were authorized to produce and sell raw cow milk and a water buffalo farm. The dairy farms were located in one province but the geographical area was variable, ranging from plains to hills; the farms had an average of 60 milking cows (from a minimum of 9 to a maximum of 216 milking cows) and the water buffalo farm had 90 lactating buffaloes. All these dairy farms, with the exception of water buffalo, must implement higher standards of hygiene practices than other dairy farms to obtain the authorization to produce and sell raw milk. The amount of raw milk sold in the province considered was estimated to be about 3,000 L per day and the number of raw milk consumers in the province considered was estimated to be 10,000 to 20,000 (Giacometti et al., 2012a). Raw milk is drunk in the investigated province without any previous effective treatment by 43% of consumers and 3.57% of consumers are children under 5 yr old (Giacometti et al., 2012a,d).

The sample size was designed using EpiTools epidemiological calculators (AusVet Animal Health Services, Toowoomba, Queensland, Australia; http://epitools.ausvet.com.au/content.php?page=home). The expected prevalence value was calculated on the basis of prevalence detected for C. jejuni in a previous study (Giacometti et al., 2012c) and on the basis of the prevalence reported for Arcobacter spp. in milk (Scullion et al., 2006; Pianta et al., 2007; Ertas et al., 2010; Shah et al., 2012).

In-line milk filters were collected at each farm 14 times, twice per week for 7 successive weeks between January and June 2011, for a total of 196 filters. The filters collected represented the group of lactating cows and lactating buffaloes at the time of sampling. Immediately after the end of milking, the fresh milk filter was collected and placed in a sterile plastic bag with enough milk from the bulk tank to completely cover the sock filter; the remaining air in the plastic bag was eliminated. Samples were placed in refrigerated coolers at 6 ± 2°C, transported to the laboratory of the Department of Veterinary Medical Sciences (Ozzano Emilia, Bologna, Italy), and processed within 6 h of sampling. After arrival at the laboratory, milk filters were aseptically weighed and cut into 2 portions for Campylobacter spp. and Arcobacter spp. detection.

**Isolation and Identification of Campylobacter spp.**

One portion of the filter was put into Bolton Selective Enrichment Broth (Oxoid Ltd., Basingstoke, UK) at a ratio of 1:10 and incubated at 37 ± 1°C under microaerobic atmosphere with hydrogen obtained by the gas replacement method with anaerobic mixture (10% H2, 10% CO2, and 80% N2). After 48 h of incubation, an aliquot of 10 μL of the enrichment broth was streaked onto the following selective media: modified charcoal cefoperazone deoxycholate agar (Oxoid Ltd., Preston selective medium (Oxoid Ltd.), and Skirrow selective medium (Oxoid Ltd.). All plates were incubated at 37 ± 1°C under a microaerobic atmosphere and examined daily up to 7 d. From each plate, different colonies of gram-negative curved- or spiral-rod bacteria were subcultivated. Isolates were identified as follows: colonies presumptive for Campylobacter spp. were subjected to DNA extraction using the NucleoSpin Tissue kit (Macherey-Nagel GmbH & Co. KG, Düren, Germany).
and submitted to a multiplex PCR protocol as described by Denis et al. (1999). From samples positive for Campylobacter genus but negative for C. jejuni-C. coli, the 16s rRNA partial sequence was amplified using universal primers 1492r and p27f (Brosius et al., 1978). The amplicons were sent to a sequencing service (Primm srl, Milan, Italy) and sequenced by ABI 3730 DNA analyzer (Primm s.r.l.). The sequences obtained were analyzed using Vector NTI Advance 10.0 software (Invitrogen, Paisley, UK) and compared with the deposited sequences of 16S rRNA using the National Center of Biotechnology Information (Bethesda, MD) network.

Isolation and Identification of Arcobacter spp.

Isolation was performed using the enrichment procedure described by Houf et al. (2001); briefly, the second portion of the filter was put into Arcobacter broth (Oxoid Ltd.) supplemented with 5% lysed horse blood, 0.5% pyruvate, and 0.5% thiglycolic acid as growth supplements and a mix of cefoperazone (16 mg/L), amphotericin B (10 mg/L), 5-flourouracil (100 mg/L), novobiocin (32 mg/L), and trimethoprim (64 mg/L) as a selective supplement. All antimicrobial substances were obtained as laboratory standard powders from Sigma (St. Louis, MO). After 48 h of incubation, an aliquot of 10 μL of the enrichment broth was streaked onto selective agar plates prepared by suspending 24 g of Arcobacter broth (Oxoid Ltd.) and 12 g of Agar Technical No. 3 (Oxoid Ltd.) and supplemented with selective supplement as described above. The plates were incubated at 30 ± 1°C under microaerobic conditions and after 48 h of incubation were checked daily up to 5 d. Different colonies of gram-negative spiral bacteria were subcultured. Isolates were identified as follows: colonies presumptive for Arcobacter spp. were subjected to DNA extraction using the NucleoSpin Tissue kit (Macherey-Nagel GmbH & Co. KG) and identified by the multiplex PCR described by Houf et al. (2000) and by Douidah et al. (2010).

Antimicrobial Susceptibility Tests

The antimicrobial agents used in the susceptibility testing were based mainly on their veterinary or human medical use, or both. For each farm investigated, 1 isolate for each Campylobacter and Arcobacter species isolated was randomly tested using the Etest method (AB Biodisk, Solna, Sweden) according to the manufacturer’s guidelines. Mueller-Hinton agar (Becton Dickinson, Franklin Lakes, NJ) containing 5% defibrinated sheep blood was used as medium. The antimicrobial agents tested were azithromycin, ciprofloxacin, tetracycline, chloramphenicol, ampicillin, erythromycin, and gentamicin. The plates were incubated at 37 ± 1°C (Campylobacter spp., Arcobacter butzleri, and Arcobacter skirrowii) and at 35 ± 1°C (Arcobacter cryaerophilus) under microaerobic atmosphere for 48 h. Campylobacter jejuni ATCC 33560, Staphylococcus aureus ATCC 29213, and Escherichia coli ATCC 25922 were used as control strains. The MIC value was recorded as the lowest concentration of an antimicrobial that completely inhibited visible growth and was read at the point where the elliptical zone of inhibition intersected the MIC scale on the strip. As Etest values are expressed on a continuous scale, data were recorded in a log2 base scale for the comparison with data obtained in the literature; Etest MIC falling in the intermediate range of the log2 scale were rounded up to the higher value.

Because specific breakpoints for defining resistance in Arcobacter spp. are not available, the criteria used in our study for the MIC resistance breakpoints for Campylobacter spp. and Arcobacter spp. were those used by the National Antimicrobial Resistance Monitoring System (NARMS) as reported in the US Centers for Disease Control NARMS (2010) annual report for Campylobacter spp. for all antibiotics tested, except ampicillin. The MIC breakpoint for ampicillin was that provided by the National Committee for Clinical Laboratory Standards (NCCLS) for Enterobacteriaceae (NCCLS, 2002). The following resistance breakpoints were used: azithromycin: ≥8, ciprofloxacin: ≥4, tetracycline: ≥16, chloramphenicol: ≥32, ampicillin: ≥32, erythromycin: ≥32, and gentamicin: ≥8.

RESULTS

Twelve farms (85.7%) out of 14 were positive at least for 1 pathogen: 5 farms were positive for Campylobacter spp. (35.7%) and 8 were positive for Arcobacter spp. (57.1%). Forty-nine out of 196 in-line milk filters were positive for at least 1 pathogen: 16 samples were positive for Campylobacter spp. (8.1%) and 36 for Arcobacter spp. (18.3%). More than 1 species was isolated in 4 farms and 4 out of 49 positive samples (all sampled in the water buffalo farm) showed the concurrent presence of 2 bacterial species. Relative to Campylobacter spp., the isolated species were C. jejuni, C. hyointestinalis spp. hyointestinalis, C. concisus, and C. fetus ssp. fetus; regarding Arcobacter spp., the isolated species were A. butzleri and A. cryaerophilus. Details on the number of positive samples and on the species isolated in each positive farm are reported in Table 1.

Four C. jejuni, 4 C. hyointestinalis spp. hyointestinalis, 1 C. concisus, 1 C. fetus ssp. fetus, 6 A. butzleri, and 3 A. cryaerophilus isolates were tested for
None of the isolates tested showed resistance to azithromycin, erythromycin, or gentamicin, with MIC values less than 0.5 and 2 μg/mL, respectively. The only *C. concisus* isolated, 1 *C. jejuni*, 1 *C. hyointestinalis* ssp. *hyointestinalis*, 1 *A. butzleri*, and 2 *A. cryaerophilus* isolates were susceptible to all antimicrobial substances tested. Two *C. jejuni*, 2 *C. hyointestinalis* ssp. *hyointestinalis*, and 1 *C. fetus* ssp. *fetus* isolate showed resistance to ciprofloxacin (MIC >32 μg/mL); 1 *C. jejuni* isolate showed resistance to ciprofloxacin (MIC >32 μg/mL) associated with resistance to tetracycline (MIC: 16 μg/mL); 1 strain of *C. hyointestinalis* ssp. *hyointestinalis* was resistant to tetracycline (MIC >256 μg/mL). Three isolates of *A. butzleri* (MIC: 32 μg/mL) and 1 isolate of *A. cryaerophilus* (MIC >265 μg/mL) showed resistance to ampicillin, and 2 *A. butzleri* isolates to chloramphenicol (MIC: 32 μg/mL).

**DISCUSSION**

To our knowledge, this is the first study to investigate the presence of emergent *Campylobacter* spp. and *Arcobacter* spp. in farms authorized to produce and sell raw milk and in a water buffalo farm by in-line milk filter examination.

Consumption or handling of raw or poorly cooked contaminated food of animal origin is one the possible routes of transmission of *Campylobacter* spp. and *Arcobacter* spp. to humans; considering that a positive milk filter is an index of potential milk contamination, the viability of several pathogenic isolates in in-line milk filters should be considered a public health question.

The observed prevalence of *C. jejuni* (3.0%) in in-line milk filters is similar to the prevalence (3.7%) reported in a previous study in the same province (Giacometti et al., 2012c) and confirms the importance of raw milk consumption as a significant risk factor for human infection.

Regarding non-jejuni/coli *Campylobacter* species, they were isolated in our study more frequently than classical thermophilic *Campylobacter* spp., namely *C. hyointestinalis* ssp. *hyointestinalis*, which was isolated from 4% of samples. This aspect is not negligible, considering that non-jejuni/coli *Campylobacter* spp. were isolated both from humans (Lastovica and Allos, 2008; Bullman et al., 2011) and animals (Oporto and Hurtado, 2011). In the literature, the isolation of *C. hyointestinalis* ssp. *hyointestinalis*, *C. concisus*, and *C. fetus* ssp. *fetus* in bovine feces has been reported (Hakkinen et al., 2007; Oporto and Hurtado, 2011) often at a higher prevalence than classical thermophilic *Campylobacter* species.

The pathogenic potential of *C. hyointestinalis* ssp. *hyointestinalis*, *C. concisus*, and *C. fetus* ssp. *fetus* has been recognized, especially in children (Lastovica and Allos, 2008; Bullman et al., 2011; Man, 2011) and at least one case of gastroenteritis has been linked to raw milk consumption (Salama et al., 1992). Moreover, as observed by Miller et al. (2012), although the frequency of human illness associated with emerging *Campylobacter* spp. might be quite low, especially when compared with *C. jejuni*-associated gastroenteritis, it is possible that some emerging species could be associated with more severe illness. One such example is *C. concisus*, for which a strong association with Crohn's

<table>
<thead>
<tr>
<th>Farm</th>
<th><em>C. jejuni</em></th>
<th><em>C. hyointestinalis</em></th>
<th><em>C. fetus</em></th>
<th><em>C. concisus</em></th>
<th><em>A. butzleri</em></th>
<th><em>A. cryaerophilus</em></th>
<th>Total positive samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>B</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>C</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>D</td>
<td>ND</td>
<td>3</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>6</td>
</tr>
<tr>
<td>E</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>8</td>
</tr>
<tr>
<td>F</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>3</td>
</tr>
<tr>
<td>G</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>3</td>
</tr>
<tr>
<td>H</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>3</td>
</tr>
<tr>
<td>I</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>3</td>
</tr>
<tr>
<td>L</td>
<td>1</td>
<td>2</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>M</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>3</td>
</tr>
<tr>
<td>N²</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>6</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>22</td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

¹ND = not detected.
²Water buffalo farm.
³Samples in which co-contamination of *Arcobacter butzleri* and *Arcobacter cryaerophilus* was detected.

Table 1. Number of positive samples for *Campylobacter* spp. and *Arcobacter* spp. detected in the 12 positive farms and number of total positive samples for both *Campylobacter* spp. and *Arcobacter* spp. for each farm.
disease and ulcerative colitis has been reported recently (Mahendran et al., 2011; Mukhopadhyya et al., 2011).

In our study, Arcobacter spp. were isolated more frequently than Campylobacter species and, in particular, from 8 out of 14 farms investigated (57.1%) and from 18.3% of samples. The Arcobacter spp. prevalence rates reported in raw milk in the literature ranged from 3.2 to 60% (Scullion et al., 2006; Pianta et al., 2007; Ertas et al., 2010; Shah et al., 2012) but the comparison of our data with previous reports must be interpreted with caution, given the different type of samples analyzed [in-line milk filters in our study, bulk tank milk in the studies of Scullion et al. (2006) and Shah et al. (2012), and individual cow milk samples in the studies of Pianta et al. (2007) and Ertas et al. (2010)] and the different isolation procedures which may have a major effect on the Arcobacter species isolated and on the isolation rate (Van Driessche et al., 2005; Shah et al., 2011). Nevertheless, considering the greater sensitivity of in-line milk filter examination, the prevalence detected in this study can be considered lower than that found in Northern Ireland (Scullion et al., 2006) and Malaysia (Shah et al., 2012) but comparable to the prevalence reported in Turkey (Ertas et al., 2010) and Brazil (Pianta et al., 2007).

Arcobacter butzleri was the most prevalent species isolated, in agreement with previous works (Scullion et al., 2006, Shah et al., 2012) but in contrast with other reports of a higher isolation rate of A. cryaerophilus (Pianta et al., 2007) or A. skirrowii (Ertas et al., 2010).

A higher number of Arcobacter spp.-positive samples (50%) were found in the water buffalo farm, frequently (28.5%) co-contaminated with A. butzleri and A. cryaerophilus (Table 1). In view of this, the role of water buffalo as potential reservoir of Arcobacter spp. and the survival capacity of the species during cheesemaking should be investigated.

The small number of isolates tested for antimicrobial susceptibility precludes any epidemiological consideration but highlights that all isolates were susceptible to macrolides and that resistance to fluoroquinolones and tetracycline was detected in the Campylobacter spp. isolates tested. Macrolides and fluoroquinolones are considered the first- and second-line drugs for complicated campylobacteriosis, whereas tetracyclines are used as an alternative (Houf et al., 2004). In our study, no resistance to macrolides was observed but the resistance to ciprofloxacin was detected in 75% of C. jejuni and C. hyointestinalis ssp. hyointestinalis isolates tested and in 1 isolate, it was associated with tetracycline resistance; fluoroquinolones and tetracyclines are frequently used for therapy in dairy herds in Italy. The observed antimicrobial resistance of isolates was not surprising and is well documented in the literature: the resistance of C. jejuni to ciprofloxacin and tetracycline from human and animal isolates was mainly attributed to the use of veterinary drugs (Levesque et al., 2007) and has been reported at different prevalence rates worldwide (Moore et al., 2006; Schweitzer et al., 2011) and in Italy (Pezzotti et al., 2003). Even the observed resistance to ciprofloxacin and (or) tetracycline in C. hyointestinalis ssp. hyointestinalis and C. fetus ssp. fetus isolates was previously described (Tremblay et al., 2003; Laatu et al., 2005; Vandenberg et al., 2006) as was the resistance of A. butzleri to ampicillin and chloramphenicol and the resistance of A. cryaerophilus to ampicillin (Fera et al., 2003; Kabeya et al., 2004; Vandenberg et al., 2006).

CONCLUSIONS

The risk connected to the presence of C. jejuni in dairy farms authorized to produce and sell raw milk was confirmed in this study and, moreover, the presence of emerging Campylobacter spp. and Arcobacter spp. represents a hazard for human health because these pathogens can contaminate raw milk and minimally processed milk products. The risk connected with the presence of these emerging pathogens should be evaluated by testing raw milk, given that a large proportion of consumers do not perform any effective treatment before milk consumption, and that raw milk is consumed by children under 5 yr old.

REFERENCES


