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Escherichia coli O157:H7 in drinking water from private water supplies in the Netherlands

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Abstract

The microbiological quality of drinking water from 144 private water supplies in the Netherlands was tested and additionally the occurrence of *Escherichia coli* O157 was examined. Faecal indicators were enumerated by using standard membrane filtration methods. The presence of *E. coli* O157 was determined using a specific enrichment method. Eleven percent of the samples contained faecal indicators whereas *E. coli* O157:H7 was isolated from 2.7% of the samples that otherwise met the drinking water standards. The *E. coli* O157 positive water supplies were located on camp-sites in agricultural areas with large grazer densities. Pulsed field gel electrophoresis (PFGE) analysis suggested that cattle might have been the cause of contamination.

Our results indicate that compliance with microbiological quality standards obtained in routine monitoring does not always guarantee the absence of pathogens. The presence of pathogens such as *E. coli* O157 may suggest possible health consequences; however, a risk assessment process should be performed as the monitoring of both faecal indicator parameters and pathogens do not predict the effect of microbial contamination of drinking water on a population.

Keywords: *Escherichia coli* O157; Gastroenteritis; Private water supply; Water microbiology; Drinking water; Detection

Abbreviations: BEAA, Bile Aesculin Azide Agar; CT-SMAC, Sorbitol MacConkey Agar with cefixime tellurite; HUS, hemolytic uremic syndrome; IMS, immunomagnetic separation; LIS, Diagnostic Laboratory for Infectious Diseases and Perinatal Screening; LSA, Lauryl Sulphate Agar; mTSB, modified Tryptone Soya Broth; NCTC, National Collection of Type Cultures; PBST, phosphate buffered saline with Tween 20; PCR, polymerase chain reaction; PFGE, pulsed field gel electrophoresis; S&B, Slanetz and Bartley Agar; SMAC, Sorbitol MacConkey Agar; SMAC-MUG, Sorbitol MacConkey Agar with 4-methylumbelliferyl-β-D-glucuronide; TTC, tetrazoliumtrichloride.

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1. Introduction

Escherichia coli O157 is a causative agent of human disease (Jones, 1999). Clinical manifestations range from asymptomatic excretion, through mild non-bloody diarrhea to hemorrhagic colitis and severe complications as hemolytic uremic syndrome (HUS) with acute renal failure, sometimes resulting in death. All age groups may be affected, but children less than 5 years of age, pregnant women and the elderly are at particular risk of developing HUS (Bolton and Aird, 1998). The number of reported cases of *E. coli* O157 infections is small compared to that caused by other enteric pathogens, but because of rising incidence worldwide and the severity of complications, *E. coli* O157 has become an increasingly recognized health problem. The annual rate of global infection is between one to three cases per 100,000 persons, but there is considerable geographic variation (Jones, 1999).

Ruminants, particularly cattle, are considered to be the main reservoir of *E. coli* O157, with a greater prevalence in dairy herds than in beef herds (Jones, 1999). Transmission of *E. coli* O157 is predominantly foodborne, particularly through undercooked ground beef or raw milk, but fruits, vegetables and non-pasteurized juices have also been implicated (Mead and Griffin, 1998). The pathogen is also transmitted by direct contact with infected farm or companion animals or their faeces (Locking et al., 2001), from one person to another, and through contaminated well and recreational water (Slutsker et al., 1998). Farmed and wild animals grazing in water catchment areas are possible sources of faecal contamination of water and therefore of waterborne *E. coli* O157 infections (Chalmers et al., 2000).

Waterborne outbreaks associated with consumption of faecally contaminated drinking water (CDC, 1999; Licence et al., 2001; Olsen et al., 2002) and recreation in or consumption of surface water contaminated with faeces have both been reported (Cransberg et al., 1996; Paunio et al., 1999). Drinking water related outbreaks of *E. coli* O157 infections have not been reported in the Netherlands to date.

In contrast to drinking water produced by drinking water companies, drinking water from private water supplies is often only partially treated or is used untreated. Particularly in rural areas and in periods with heavy rainfall, insufficient protection of wells can lead to contamination (Olsen et al., 2002) with contaminated surface water or by leaching of animal faeces. The well that was the source of the Walkerton outbreak of *E. coli* O157 and *Campylobacter jejuni* infections in 2000, appeared to be under the influence of contamination by surface water and vulnerable to contamination from agricultural activities (Hrudey, 2004). Rutter et al. (2000) found that the microbiological quality of private water supplies in England is poor compared with public water supplies. Total coliforms, including *E. coli*, were detected in 42% of the examined supplies on at least one occasion. Over the last 30 years, 25 outbreaks of infection associated with private water supplies have been reported in England and Wales (Said et al., 2003). *Campylobacter* was implicated in 52% of the outbreaks; one outbreak was due to *E. coli* O157. Other *E. coli* O157 outbreaks related to private water supplies have been reported in the USA (Jackson et al., 1998) and Scotland (Licence et al., 2001). In both outbreaks the infection spread from infected animals to man via contamination of the water supply.

The current Dutch Drinking Water Act (Anon, 2001a) requires owners of private water supplies to test the quality of the drinking water they produce and distribute to third parties. The Dutch Drinking Water Act is directly derived from and with respect to faecal indicator parameters identical to the European Drinking Water Directive 98/83/EG (Anon, 1998). Before this Act became operational, there was no obligation for owners of private water supplies to test the quality of the drinking water produced. Drinking water produced for domestic use only is outside the scope of this Act. Private water supplies with groundwater sources and a maximum production of $100\,m^3$ per day need an approved water quality testing program including the examination of 13 source and four tap water samples for the presence of total coliforms and *E. coli* per year. Private water supplies with surface water sources must additionally examine one sample per year for the presence of intestinal enterococci. Dutch drinking water legislation requires the use of specified standard enumeration methods for these parameters and the examination of 100 ml sample volumes. We studied compliance of the microbiological quality of drinking water from private water supplies with Dutch drinking water legislation by testing for the presence of total coliforms, *E. coli* and entercococci, and additionally studied the occurrence of *E. coli* O157 in this drinking water.

2. Materials and methods

2.1. Water samples

Drinking water from 144 private water supplies located at camp-sites, offices, hospitals and breweries throughout the Netherlands was sampled during the summers of 2002 and 2003 at the consumer's tap. All private water supplies included in this study used groundwater sources for drinking water production. Samples were taken and handled according to ISO 5667 (Anon, 1991) and analysed within 24 h from sampling. Repeat samples were taken from all positive water