



An assessment of available information on raw milk cheeses and human disease 2000–2010

MAF Technical Paper No: 2011/58

A report prepared for the
Ministry of Agriculture and Forestry
by Dr William F Hall
Professor Nigel French

ISBN 978-0-478-38457-4 (online)
ISSN 2230-2794 (online)

April 2011



Ministry of Agriculture and Forestry
Te Manatū Ahuwhenua, Ngāherehere



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MAF Information Bureau
P O Box 2526
WELLINGTON

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MASSEY UNIVERSITY
COLLEGE OF SCIENCES
TE WĀHANGA PŪTAIAO

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ki Pūrehuroa

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Executive summary

Disease outbreaks associated with the consumption of raw milk cheeses continue to occur around the world despite the warnings of public health officials, as evidenced by the material reviewed in this report.

Fifteen databases were searched using the search terms 'cheese' or 'raw milk cheese'. Each report was given a value based on the evidence to support the value of the report.

A total of 41 reports of all types were found which covered more than 50 outbreaks related to raw milk cheese consumption. In many cases, the human illness resulted from the failure to implement basic hygiene measures during cheese manufacture, or the consumption of cheese illegally produced or imported.

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1 Introduction

This study was undertaken at the request of the New Zealand Food Safety Authority/Ministry of Agriculture and Forestry to update the raw milk cheese component of a previous study of human disease associated with raw milk and raw milk products, titled ‘A systematic review of the human disease evidence associated with the consumption of raw milk and raw milk cheeses’ (Jaros et al. 2008).

The Jaros study assessed a large number of reports and classified each one as a Type 1 or Type 2 study (see definitions, page 5 footnote Jaros et al.) to determine its suitability for further assessment (the internal validity of the report). Those reports Jaros et al. deemed unsuitable for assessment (Type 2 studies) were not examined beyond that point, but are considered in this report.

This current study did not carry out a systematic evaluation of new material that became available after August 2008 (as per the Jaros et al. report). This study reports on case material dating from 1 January 2000 up to 31 December 2010, in which raw milk cheeses were implicated in human disease. This case material includes peer-reviewed scientific papers, reports, press releases and relevant recall notices. Forty one documents were retrieved and assessed and included in the data tables. All available information has been tabulated and an overall assessment of the value of the individual reports given, based on several criteria.

Despite ongoing warnings by regulatory agencies in many countries, disease outbreaks directly attributable to the consumption of cheese manufactured from raw (non-pasteurised) milk continued to occur over the period under study. In most outbreaks, contamination of the cheese after manufacture was not identified. Multi-national outbreaks were noted to rarely occur, and when they did, were often associated with the export of cheeses, particularly within the European Union, or the illegal importation of soft cheeses, for example, cheese manufactured in Mexico and consumed in the USA. Several cases of consumption of a cheese in one country and a subsequent diagnosis of disease in another were noted, all involving *Brucella melitensis*.

In many instances, most notably in the USA, the disease outbreak could be attributed to the failure to implement sanitary measures as required by regulatory authorities where the sale of raw milk and raw milk products was permitted.

2 Materials and methods

The definition of a disease outbreak was obtained from the New Zealand *Disease Outbreak Manual* (2002), namely:

An epidemic limited to a localised increase in the incidence of a disease, such as in a village, town, or closed institution.

However, in some reports, the disease was limited to one or two persons in a family that had been exposed to a raw milk cheese, particularly so for cases of brucellosis.

The following databases were searched using the search terms ‘cheese’ or ‘raw milk cheese’, if possible limiting the results to the period 1 January 2000–31 December 2010:

PubMed	Google Scholar	Scopus
Web of Knowledge	CDC (MMWR Weekly)	Eurosurveillance
FDA Recall Notices	Food Safety Agency (UK)	Centre for Science in the Public Interest
Canadian Food Inspection Agency	Ozfoodnet	WHO (www.who.int/gfn/en)
EnterNet	Foodpoisonjournal www.foodpoisonjournal.com .	US State Government websites

Information was solicited from the state epidemiologist for several US states and, if possible, authors of particular published papers. Several websites listed outbreaks, but the source of the information was not fully identified so that further information could not be obtained. In several cases, internet sites were no longer active.

3 Results

A listing of all documents examined is set out in the References section of this report. In some cases the publication date of the journal was after 1 January 2000, but the outbreak occurred in the late 1990s—these reports have not been included.

The quality of the reports varied considerably, ranging from well conducted retrospective case-control studies to press releases based on reports of a single possible case that had not been fully investigated. Sometimes, an outbreak which led to an initial report in *Morbidity and Mortality Weekly Report* (MMWR) would be reported several years later in a peer-reviewed journal. In several instances, local recalls due to a reported illness, for example those initiated by the US Food and Drug Administration, were not covered further in identified literature.

As expected, all disease investigations were initiated as a result in an increased incidence of disease, or increasing numbers of isolations, or identifications of a particular pathogen or of a previously rarely reported pathogen. This was followed up by either a detailed case control study, or simply an investigation into the cause of the disease outbreak, and/or a search for more cases. The last situation occurred when brucellosis was diagnosed in a single person and subsequently found in other asymptomatic but serologically positive persons.

Tables 1–8 provide the relevant information extracted from each report. Each report has been given a ‘score’ based on the strength of the evidence to assess the value of the report. The evidence was assessed using 4 criteria:

1. Epidemiological and laboratory evidence
2. Clinical evidence and/or symptoms
3. Isolation of the agent from the case and/or the suspected source
4. A calculated Odds Ratio or Relative Risk.

The values given to the evidential scores were 3 (highest) to 1 (lowest). Documents meeting all the 4 evidence criteria were scored 3, whilst a press recall notice would score 1 because such notices were often based on limited clinical evidence. Scores are based on current reports, and based on past experience; some of the most recent outbreaks may ‘grow’ in future reports following more detailed investigations or simply the completion of an ongoing investigation.

4 Summary

Disease outbreaks associated with the consumption of raw milk cheeses continue to occur around the world despite the warnings of public health officials, as evidenced by the material reviewed in this report.

Fifteen databases were searched using the search terms ‘cheese’ or ‘raw milk cheese’. Each report was given a value based on the evidence to support the value of the report.

A total of 41 reports of all types were found which covered more than 50 outbreaks related to raw milk cheese consumption. In many cases, the human illness resulted from the failure to implement basic hygiene measures during cheese manufacture, or the consumption of cheese illegally produced or imported.

Table 1. *Brucella* spp.

Mendez et al. <i>Eurosurveillance</i> 8 (7) Article 421 Year: 2003						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Brucella melitensis</i> serovar 3. Agent was serotyped in clinical specimens collected from cases.	Unpasteurised goat cheese	Agent not isolated from cheese. Agent isolated from goat tissues and milk samples. Goats on the implicated farm were seropositive (November 2001 and April 2002).	Eleven cases confirmed; no suspects, no fatalities. Cases were aggregated in 7 families.	Journal article (case control)	3 OR 21.6 (95%CI 1.6–639.8) for cases having eaten cheese at a farm house located in the endemic area. Overall OR for cases having eaten unpasteurised goat cheese 37.4 (95%CI 3.18-2201).	Outbreak Spain January–March 2002
						National (3 close communities)
						Cheese produced at a local farmhouse; 26 goats seropositive for <i>Brucella melitensis</i> April 2002.

Al Dahouk et al. <i>Eur J Clin Microbiol Infec Dis</i> 24 450–456 Year: 2005						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Brucella melitensis</i> (30 cases) and <i>Brucella suis</i> (1 case)	Unpasteurised goat and sheep milk products consumed in endemic countries.	Agent isolated from blood culture of human cases on return to Germany from overseas.	Thirty cases identified by blood culture (28 cases travel-associated). Thirty-two cases diagnosed by serology. Review of records of 30 cases revealed two peak ages, 10–30 years (30% of cases and > 50 years of age (47% of cases reviewed). No fatalities.	Journal (retrospective case study)	2	Germany 2002–2003
						National
						Infection acquired overseas (perhaps in Turkey) by travellers. Study based on positive <i>Brucella</i> isolations by German Reference Laboratory.

Iaria et al. <i>Emer Inf Dis</i> 12: (12) 2001–2002 Year: 2006						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Brucella melitensis</i>	Sheep milk cheese ('tuma' and ricotta)	Diagnostic method not described. Not known whether the agent was isolated from cheese.	Twenty-nine reported cases (18 cases were members of 9 families). Median age of child cases (8/29) 10.5 years range 6–13. Median age of adults 42, range 16–67. No fatalities.	Letter to the editor (Case report)	1	Italy 2003
						Local occurrence Messina Province
						Cheese was consumed by clinical cases at a live nativity scene where fresh cheese from sheep milk was produced and sold.

Celebi et al. <i>Scandinavian Journal of Infectious Diseases</i> 39: 205–208 Year: 2007						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Brucella melitensis</i> biovar 3	Goat cheese made from raw goat milk.	No cheese available for testing. Agent isolated from blood from all 4 cases and human breast milk from 1 asymptomatic case.	Four (2 asymptomatic), all members of the same family. Index case 10 year old boy. Parents of the boy, 37 year old father (symptomatic) and 34 year old mother, 12 year old sister to index case (asymptomatic). No fatalities.	Journal article (case report traceback)	2	Turkey. Date not specified but likely 2005.
						Local
						Infection acquired in Turkey.

Jennings et al. <i>Transactions of the Royal Society of Tropical Medicine and Hygiene</i> 101:707–713 Year: 2007						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Brucella</i> spp. diagnosis may have been based on serology alone, or isolation of <i>B. abortus</i> or <i>B. melitensis</i> .	Soft cheese or yoghurt made from unpasteurised milk (presumably cow or goat).	Serological diagnosis titre $\geq 1:320$ (206/321 cases), or isolation from blood culture (115/321 cases).	A survey of patients presenting with acute febrile illness resulted in 321 cases of brucellosis in 2002/2003. One hundred and sixty of 186 cases identified in 2003 had consumed soft cheese or yoghurt. Median age of all cases was 25 years. Seventy per cent of all cases	Journal article (retrospective study based on identification of cases).	2	Egypt 2002 and 2003
						Local, Fayoum Governorate
						No milk products tested for the presence of <i>Brucella</i> spp.

Jennings et al. <i>Transactions of the Royal Society of Tropical Medicine and Hygiene</i> 101:707–713 Year: 2007						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
			were males.			
Farina et al. <i>Le Infezioni in Medicina</i> n. 3, 154-157 Year: 2008						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Brucella melitensis</i>	Sheep milk cheese (pecorino) imported from an endemic area of Italy.	Unknown whether agent isolated from cheese. In 2 clinical cases, <i>B. melitensis</i> was cultured. Three other cases were seropositive.	Five cases limited to members of 1 household. Index case 29 years old. No other suspects and no fatalities.	Journal article in Italian. Summary in English only (translation of the article now available). Case study.	2	Italy August 2005 Local occurrence, Treviso Province Cheese imported from an endemic area of Italy.

Table 2. *E. coli* O157:H7

Honish et al. <i>Can J Pub Hlth</i> 96:3:182–184 Year: 2005						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>E. coli</i> O157:H7	Unpasteurised gouda cheese made from cow milk.	Agent isolated from cheese. All on-farm milk tests were negative for <i>E. coli</i> O157:H7.	Thirteen cases. Median age 26 years, range 22 months–73 years. Seventy-seven per cent of the cases were female. Twelve of 13 clinical cases reported eating cheese from the implicated manufacturer. Two cases aged 22 months and 4 years developed HUS. No fatalities.	Journal article, case report	2	Canada October 2002–February 2003
						Local; Edmonton Alberta
						First case involving hard cheese in Canada.
Espie et al. <i>Epidemiol Infect</i> 134: 143–146 Year: 2006						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>E. coli</i> O157:H7	Unpasteurised cheese made from goat milk. Farm also made cow milk cheeses.	<i>E. coli</i> O157:H7 <i>stx2+</i> , <i>eae+</i> from 1 case only. <i>E. coli</i> O157:H7 <i>stx2+</i> , <i>eae+</i> from faeces of a cow on the farm.	Family cluster of 3 cases; adult male age unknown, boy 13 months and a girl aged 3. No fatalities.	Journal article, case report	2	France June 2004
						Local; cheese purchased from a farm. Cheeses also sold locally.
						First cases associated with raw goat milk cheese in France.

FDA News release 4 November 2010 (updated 24 November 2010) Year: 2010						
CDC Investigation Update 24 November 2010 Year: 2010						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>E. coli</i> O157:H7	'Bravo Farms' Dutch Style Gouda Cheese made from raw milk (opened and unopened packages).	Agent isolated from cheese. Not reported whether the agent was isolated from milk.	Thirty-eight cases in 5 states as of 24 November 2010: AZ (19), CA (3), CO (11), NM (3) and NV (2). Median age 16 years, range 1–85 years. One case of HUS. No information concerning any other suspected cases and no fatalities reported.	News release relating to a product recall.	1	USA 2010
						National outbreak, 5 states
						Product sold through a large retail outlet.

FDA News release 17 December 2010 Year: 2010						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>E. coli</i> O157:H7	'Sally Jackson' cheeses as a possible source. Cheese type not specified	Agent isolated from cases in Oregon and Washington states. Agent not isolated from cheese.	Eight possible cases in Oregon and Washington states. Limited information on cheese consumption, only 1 case definitely ate 'Sally Jackson' cheese. Two suspect cases in Minnesota. No fatalities.	News release relating to a product recall and warning.	1	Oregon and Washington between September and November 2010
						National, but geographically closely related (cheese distributed to 17 states in the USA).
						Whether the milk was contaminated, or contamination occurred post-production, is not clear.

Table 3. *Campylobacter* spp.

California CD Brief dated 11 February 2004) Year: 2004						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Campylobacter</i> spp. isolated from 1 case. In later examination of similar cheese from the same source, <i>Listeria monocytogenes</i> and <i>L. innocua</i> were isolated.	Mexican soft cheese ('queso fresco') imported from Mexico.	Only 3 stool samples were examined. One sample was lost, 1 sample was negative and 1 positive. Cheese was not available for testing.	Eleven cases, 6 suspects (17 attendees) at a pot luck dinner. No fatalities.	Communications brief with limited distribution	1	California outbreak October 10 2003
						Local community
						Cheese imported from Mexico 4 days prior to serving at a pot luck dinner.
MMWR Weekly January 2, 2009 57 (51&52); 1377–1379 Year: 2009						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Campylobacter jejuni</i>	Soft cheese made from unpasteurised milk.	From clinical cases only	Sixty-seven cases. A total of 101 persons reported eating cheese. Median age of cases 25 years, range 1–75 years. 41 cases were aged ≤ 15 years. Fifty-four per cent of cases were women. No fatalities.	Journal article, case report	2 RR 13.9 for cases who ate cheese.	Kansas October 2007
						Local community
						Eating cheese at the fair was the only risk factor.

Washoe County Nevada Press release Year: 2010						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Campylobacter</i> spp, no further identification provided in the press release.	Mexican soft cheese ('queso fresco') made with unpasteurised milk	Agent isolated from cheese and clinical case.	One case (child age unknown) only identified in this press release. No other suspects and no fatalities.	Press release	1	Nevada May 2010
						Local case
						Cheese purchased from a door-to-door salesperson.

Table 4. Tick-borne encephalitis virus

Holzmann et al. <i>Emerg Infect Dis</i> 15: (10) 1671–1673 Year: October 2009						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
TBEV infection confirmed by ELISA.	Mixed goat and cow milk cheese. No samples were available.	Case diagnosis by serology. One goat seropositive to TBEV.	Six confirmed cases on the basis of serology. Index case was a 43 year-old male. Other cases age range 7–65 years. One suspect case, no fatalities.	Journal article, case report	2	Austria July 2008 Local occurrence Only one batch of cheese suspected of being responsible for the transmission of the TBEV. Four pigs on the farm fed whey and goat milk also sero-positive.

Table 5. *Listeria monocytogenes*

Boggs et al. <i>MMWR</i> 50 (26);560–562 Year: 2001						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Listeria monocytogenes</i>	Home-made Mexican-style cheese	Agent isolated from cheese.	Twelve cases identified. No fatalities.	Report	1	North Carolina USA October 2000–January 2001
						This case is further described by MacDonald et al. in <i>Clinical Infectious Diseases</i> 2005
						Local outbreak

Canadian Communicable Disease Report Volume 29–21 1 November 2003 Year: 2003						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Listeria monocytogenes</i> (pulsotype 85 [cheese and human cases]) and environment	Four types of cheeses made from unpasteurised cow milk (milk was heated but not pasteurised).	Agent isolated from cheese and clinical cases.	Seventeen cases, 10 females, 7 males. Mean age 43 years. When 3 newborns were excluded, the mean age was 56 years. Two premature births. No fatalities.	Report	2	Quebec 2002
						Local outbreak
						The production site was contaminated with soil during renovations, and as a consequence contaminated with <i>L. monocytogenes</i> .

Carrique-Mas et al. <i>Epidemiol Infect</i> 130: 79–86 Year: 2003						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Listeria monocytogenes</i> serotype 1/2a	Locally manufactured cheeses with either raw cow or raw goat milk from a summer farm	Agent isolated from all clinical cases, milk and cheese.	Forty-eight cases identified (2 cohorts identified [one visited the farm, the other identified by local doctors]). Average age 52 years, range 2–85 years. Severity of illness was dose-related. No fatalities.	Peer-reviewed journal article (retrospective case control)	2 RR 2.23 (95% CI 1.49 – 3.34) for cow milk cheeses. Poor choice of controls	Sweden 2001
						Local outbreak, cheese sold from a local farm
						The Environmental Health Authority deemed the cheese and butter as the source of the outbreak.

MacDonald et al. <i>Clinical Infectious Diseases</i> 40:677–82 Year: March 2005						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Listeria monocytogenes</i>	Home-made Mexican-style cheese using milk from a single source.	Agent isolated from clinical cases, milk (a single dairy) and cheese.	Thirteen cases (12 women, 11/12 pregnant). All were of Hispanic origin. Median age of the women was 21 years, range 18–38 years. Of the 11 pregnant cases, there were 5 stillbirths, 3 premature births and 3 infected newborns. Five fatalities (stillbirths).	Journal (case control)	3 Matched OR 17.5 (95% CI 2.0 – 152.5) if cheese bought from door-to-door vendor.	Reports the findings of <i>MMWR</i> Vol. 50, July 6 2001, No. 26: 560–562 outbreak occurred between October 2000 and January 2001.
						Local US State of North Carolina
						Contaminated raw milk sold to unlicensed cheese makers.

Makino et al. <i>Int J Food Microbiol</i> 104: 189–196 Year: 2005						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Listeria monocytogenes</i> serotype 1/2b isolated from cases, cheese and environment.	Cow milk cheese (the primary author of this paper, when contacted, indicated that the milk used had been pasteurised).	Agent isolated from cheese and clinical cases.	Eighty-six cases identified, 38 with clinical signs. No fatalities.	Peer-reviewed article (investigation)	2	Japan 2001
						Local outbreak
						First reported case of food-borne listeriosis in Japan

Bille et al. <i>Eurosurveillance</i> Volume 11, Issue 6, 01 June 2006 Year: 2006						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Listeria monocytogenes</i> serotype 1/2a	‘Tomme’, a local soft cheese made from skim milk, produced by one local manufacturer.	Agent isolated from several cheese samples and all clinical cases.	Ten cases, 2 suspect cases. Male cases age range 70–72, pregnant women age 23 and 26 years old. Older women 59–82 years of age. 5 fatalities: 3 deaths in older cases, 2 cases of septic abortion.	Journal article (investigation)	2	Switzerland 2005
						Local outbreak
						Unlikely that the milk was pasteurised

FDA press release Year: 2010						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Listeria monocytogenes</i>	'Queso fresco' fresh cheese	No information	One case linked to the cheese	Press release related to product recall	1	USA Washington State 2010
						Local
						Very limited information in the release

Fretz et al. <i>Eurosurveillance</i> 15 (16): Article ID 19543 Year: 22 April 2010						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Listeria monocytogenes</i> (2 clones identified, both being strain 1/2a).	'Quargel' (sour milk cheese). Whether or not unpasteurised milk used in production is not stated.	Agent isolated from cheese and clinical cases.	Thirty-four cases identified in 3 countries, median age 72 years, range 57–89 years. Twenty-six of 34 cases were male. Twenty-five Austrian cases from 7/8 Austrian provinces. Eight fatalities, 5 in Austria and 3 in Germany.	Journal (case control)	3 OR 76.6 (95% CI 9.3 -∞) p value <0.001	Austria June 2009–January 2010 and Germany December 2009–February 2010
						International
						Product exported to German, Czech and Slovakian markets.

Table 6. *Mycobacterium bovis*

MMWR Weekly June 24, 2005/54 (24); 605–608 Year: 2005						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Mycobacterium bovis</i>	'Queso fresco' cheese imported into New York City from Mexico is suspected to be the source of the infection.	Clinical cases	Thirty-five cases of human TB attributed to <i>M. bovis</i> . Twenty of 35 cases born in Mexico. Twelve of 35 cases < 15 years of age, 5/35 cases < 5 years of age (all born in the USA). Twenty-three of 35 people were adults (median age 27 years, range 16–76 years). One fatality, a male aged 15 months. Nineteen of 23 cases reported eating cheese imported from Mexico.	Report on an investigation	1	Thirty-five TB cases in NY City 2001–2004 due to <i>M. bovis</i>
						Local Continual risk associated with the illegal importation of cheese from Mexico. Cases of <i>M. bovis</i> TB in San Diego (California) have also been thought to have been associated with cheeses imported from Mexico.

Table 7. *Salmonella* spp.

McCarthy et al. International Conference on Emerging Diseases, Atlanta Georgia USA. Board 84 p 95 Year: August 2002						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Salmonella Newport</i>	Three soft Italian cheeses made with unpasteurised milk.	Agent isolated from milk and clinical cases.	Twenty-six cases identified, based on PFGE type as the initial cases. No fatalities.	Conference abstract	2	Connecticut April 2001
						State-wide, 5 counties
						Inadequate heat treatment of milk

Haeghebaert et al. <i>Eurosurveillance</i> 8 (7) Article 419 See also Brisabois et al. <i>Eurosurveillance</i> Volume 5, Issue 33 16 Aug 2001 Year: July 2003						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Salmonella enteritidis</i> Phage type 8	Fresh Cantal cheese from a single manufacturer using cow milk.	Cows excreting <i>Salmonella</i> identified on the farm supplying milk. Agent isolated from cheese and clinical cases.	One hundred and ninety cases in the first outbreak, 25 cases in the second outbreak. No fatalities.	Journal (case control)	3 OR 7.5 (95% CI 2-41) p value <0.01. Second outbreak, OR4.1(95%CI 1.1-15) p=0.01	France June–July 2001 and October 2001
						Community outbreak
						Auto controls had identified <i>Salmonella</i> at the manufacturing farm (first outbreak) but no action taken at this time. Source of the second outbreak not identified.

Espie and Vallant <i>Eurosurveillance</i> Volume 10, Issue 32, 11 August 2005 Year: 2005						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Salmonella enterica</i> serotype Stourbridge	Unpasteurised goat cheese (2 brands) from a single French producer and cross-contamination with infected cheese.	Agent isolated from milk, cheese and clinical cases.	Fifty-two cases in 7 European countries; 27 in France, 25 in the other European countries. No fatalities reported	Journal-case report	2	April–July 2005
						National and international outbreak. France, Sweden, Switzerland, Germany, Austria, UK and The Netherlands
						On the farm a single goat (1/260) identified as an excreter of <i>Salmonella</i>

van Duynhoven et al. <i>Epidemiol. Infect.</i> 137: 1548–1557 Year: 2007						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Salmonella typhimurium</i> DT7	Hard cheese produced from unpasteurised cow milk	Milk bulk tank was positive in 2005. The agent was isolated from cheese and clinical cases.	Two hundred and twenty-four laboratory-confirmed cases. Median age 7.7 years, range 0–93 years. No fatalities.	Peer-reviewed journal article (case control on a subset of cases).	3 OR 7.1 (95% CI 2.1 – 23.8) for hard cheese purchased from farm	The Netherlands January 2006–April 2007
						National outbreak (58% of cases from one local region)
						Excreter cows and seropositive cows on the farm

MMWR Weekly November 9 2007/56 (44); 1161–1164 Year: 2007

Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Salmonella typhimurium</i> , <i>Listeria monocytogenes</i> and <i>Campylobacter jejuni</i>	'Queso fresco' made from unpasteurised milk purchased from the implicated farm	<i>S. typhimurium</i> isolated from cases, raw milk but not cheese. <i>L. monocytogenes</i> and <i>C. jejuni</i> also isolated from raw milk tank samples. Agents were also isolated from clinical cases	Twenty-nine cases associated with raw milk or raw milk cheese in 3 clusters. No fatalities.	Report	1	Pennsylvania February 2007.
						Local limited; to 1 state (Pennsylvania)

MMWR Weekly April 25, 2008 57(16);432–435 Year: 2008

Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Salmonella enterica</i> serotype Newport	'Cotija' Mexican-style cheese manufactured from unpasteurised cow milk suspected.	Agent isolated from bulk milk tank, cheese and clinical cases.	Eighty-five culture-confirmed cases. Ten of 17 cases with onset of diarrhoea (December 30 2006–February 26 2007) reported eating Mexican-style cheese. No fatalities.	Report (case control)	2 Depending on the type of cheese, matched OR values ranged between 1.1 and 3.0.	Illinois March 2006–April 2007. Follow-up on case reported in Illinois beginning in March 2006
						Community; 9 counties in northern Illinois
						Dairy farm with a history of illegal unpasteurised milk sales

Pastore et al. <i>Eurosurveillance</i> Volume 13 Issue 37 11 Sep 2008 Year: 2008						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Salmonella enterica</i> serotype Stanley	'Brand X' soft cheese (Raclette – a melted semi-hard cheese) manufactured from thermised milk at a single site.	Agent isolated from cheese and 77 of 82 clinical cases.	Eighty-two cases documented. Mean age of cases 45.7 years, range 0–92 years. Forty-one per cent of cases reported eating 'Brand X' soft cheese. No fatalities related to <i>Salmonella</i> infection.	Journal article (retrospective case-control)	3 Adjusted OR 11.4 (95% CI 1.9 – 69.6) p value =0.008	Switzerland September 2006–February 2007
						National
						First cases in Europe not related to imported food. Source of contamination not identified.

Dominguez et al. <i>Foodborne Pathogens and Disease</i> 6: (1) 121–128 Year: 2009						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Salmonella enterica</i> serotype Montevideo	Cheese 'Type X', manufactured from raw cow milk	Agent isolated from a single farm supplying raw milk that had an episode of <i>Salmonella enterica</i> serotype Montevideo in Sep/Oct 2006. Agent also isolated from cheese and clinical cases.	Twenty-three cases in total. Median age 35 years, range 1–83 years. Sixteen of 23 cases were women. Eight of 12 cases interviewed ate suspected cheese. Two people died shortly after isolation of <i>Salmonella</i> (age at death not given but case age range 1–83 years).	Peer-reviewed journal (case control)	3 Matched OR 6.7 (95%CI 0.7 – 62.6) p-value = 0.10	France October 2006–January 2007
						Nation-wide distribution via supermarkets
						Plant produced 3,600 kg of cheese per day.

Van Caeteren et al. *Eurosurveillance* 14:Issue 31:1–3 (August 2009) **Year:** August 2009

Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Salmonella enterica</i> serotype Muenster	Goat milk	Agent isolated from cheese and clinical cases.	Twenty-five laboratory-confirmed cases. Median age of adults, (21 cases) was 58 years (range not given). Four cases in children 8–12 years old. Sixteen of 21 cases interviewed reported eating goat cheese (from the same producer) prior to disease onset. No fatalities.	Journal (case report)	2	France, March and April 2008
						Nation-wide outbreak
						Product had also been distributed to Belgium, Germany, The Netherlands and Sweden. No cases in these countries related to the French outbreak.

Table 8. *Staphylococcus* and *Streptococcus* spp.

Kuusi et al. BMC Infectious Diseases 6:36 Year: 2006						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Streptococcus equi</i> subspecies <i>zooepidemicus</i>	Fresh goat cheese from a single farm	Agent isolated from milk bulk tank, cheese, 1 goat and clinical cases.	Seven subjects (5 females, 2 males median age 70, range 54–93) met the case definition (bacteria isolated from a normally sterile site). Six of 7 had consumed cheese from the implicated farm, 1/7 had probably eaten implicated cheese. No fatalities.	Peer-reviewed journal article –case report	2	Finland September–October 2003
						Local, cheeses distributed to 14 retail stores
						Infected goat 1/40 identified (vaginal swab)
Bordez-Benitez et al. Eur J Clin Microbiol Infect Dis 25:242–246 Year: 2006						
Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Streptococcus equi</i> subspecies <i>zooepidemicus</i> isolated from raw milk and 15 cases.	‘Queso fresco’ cheese made from inadequately pasteurised cow milk from 2 farms.	Agent isolated from milk and clinical cases.	Fifteen cases (5 females, 10 males, median age 70 years, range 47–76), no other suspected cases. Five of 15 people died from the infection. Age at death ranged from 68–86 years. Twelve of 15 cases also had underlying disease.	Peer-reviewed journal article –case report. Controls selected from the hospital population.	3 OR 4.5 (95% CI 1.57 – 19.7 p<0.001)	Canary Islands February–April 2003
						Local outbreak
						Cheese consumed in 9/15 cases.

Ostyn et al. *Eurosurveillance* 15:Issue13:1–4 (April 2010) Year: 2010

Agent isolated	Type of cheese	Where agent isolated from	No. people involved	Report type	Score	Comments
<i>Staphylococcus aureus</i> producing type E enterotoxin. Isolates carried <i>see</i> gene.	Soft cheese made by a single producer from unpasteurised cow milk.	All 3 batches of cheese implicated in the outbreak. Diagnosis of cases appears to be based on clinical signs only.	Twenty-three cases associated with 6 outbreaks. Twenty-three of 26 people who had eaten the implicated cheese developed clinical signs attributable to <i>Staphylococcal</i> food poisoning. No fatalities.	Case report	2	Outbreaks in October and November 2009 in France
						National outbreak in 6 departments
						Three batches of cheese manufactured over a 2-week period distributed to supermarkets.

5 References

1. Al Dahouk S., Nockler K., Hensel A., Tomaso H., Scholz H.C., Hagen R.M., Neubauer H. (2005) Human brucellosis in a non-endemic country: A report from Germany, 2002 and 2003. *European Journal of Clinical Microbiology and Infectious Diseases* 24:450–456.
2. Anon. (2001) Outbreak of listeriosis associated with homemade Mexican-style cheese – North Carolina, October 2000–January 2001 *MMWR* Vol. 50 2001 July 6, / No. 26: 560-562 <http://www.cdc.gov/mmwr/PDF/wk/mm5026.pdf>
3. — (2005) Human tuberculosis caused by *Mycobacterium bovis*- New York City, 2001–2004. *MMWR* June 24, 2005 / 54(24);605-608
<http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5424a4.htm>
4. — (2007) *Salmonella typhimurium* infection associated with raw milk and cheese consumption – Pennsylvania, 2007. *MMWR* November 9, 2007 / 56(44); 1161-1164
<http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5644a3.htm>
5. — (2008) Outbreak of multidrug-resistant *Salmonella enterica* serotype Newport infections associated with consumption of unpasteurised Mexican-style aged cheese - Illinois, March 2006–April 2007. *MMWR* April 25, 2008 / 57(16);432-435
<http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5716a4.htm>
6. — (2009) *Campylobacter jejuni* infection associated with unpasteurised milk and cheese - Kansas, 2007. *MMRW* January 2, 2009 / 57(51&52); 1377-1379.
<http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5751a2.htm> See also reference Kansas Department of Health and Environment 2007.
7. Bille., Blanc DS., Schmid H., Boubaker K., Baumgartner A., Siegrist HH., Tritten ML., Lienhard R., Berner D., Anderau R., Treboux M., Ducommun JM., Malinverni R., Genné D., Erard P., Waespi U. (2006) Outbreak of human listeriosis associated with tomme cheese in northwest Switzerland, 2005. *Eurosurveillance* 2006;11(6):pii=633. Available online: <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=633>.
8. Bordes-Benítez A., Sánchez-Oñoro M., Suárez-Bordón P., García-Rojas A. J., Saéz-Nieto J. A., González-García A., Álamo-Antúnez I., Sánchez-Maroto A., Bolaños-Rivero M. (2006) Outbreak of *Streptococcus equi* subsp. *zooepidemicus* infections on the island of Gran Canaria associated with the consumption of inadequately pasteurised cheese. *European Journal of Clinical Microbiology and Infectious Diseases* 25: 242–246.

9. Brisabois A., Grimont F., Vaillant V., Bouvet P., Haeghebaert S., Sulem P. (2001) *Salmonella enteritidis* outbreak phage type 8 in southwest France from contaminated Cantal cheese. *Eurosurveillance* . 5(33):pii=1702. Available online: <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=1702>.
10. California CD Brief (2004) Report of meeting of 02/11/04 (Week 6) Another GI outbreak associated with Queso Fresco.
<http://www.lapublichealth.org/spa7/docs/CD2114.pdf>
11. Carrique-Mas J. J., Hökeberg I., Andersson Y., Arneborn M., Tham W., Danielsson-Tham M.-L., Osterman B., Leffler M., Steen M., Eriksson E., Hedin G., Giesecke J. (2003) Febrile gastroenteritis after eating on-farm manufactured fresh cheese – an outbreak of listeriosis? *Epidemiology and Infection* 130:79–86.
12. CDC (2010) Investigation Update: Multistate outbreak of *E. coli* O157:H7 infections associated with cheese. [http://www.cdc.gov/ecoli/2010/cheese\)157/index.html](http://www.cdc.gov/ecoli/2010/cheese)157/index.html).
13. Çelebi G., Kūlah C., Kiliç S., Üstündağ G. (2007) Asymptomatic *Brucella* bacteraemia and isolation of *Brucella melitensis* biovar 3 from human breast milk. *Scandinavian Journal of Infectious Diseases* 39: (3): 205–208.
14. Dominguez M., Jourdan-Da Silva N., Vaillant V., Pihier N., Kermin C., Weill F., Delmas G., Kerouanton A., Brisabois A., de Valk H. (2009) Outbreak of *Salmonella enterica* serotype Montevideo infections in France linked to consumption of cheese made from raw milk. *Foodborne Pathogens and Disease*. February 2009, Vol. 6, No. 1: 121–128.
15. Espié E., Vaillant V. (2005) International outbreak of *Salmonella Stourbridge* infection, April–July 2005: results of epidemiological, food and veterinary investigations in France. *Eurosurveillance*. 2005;10 (32):pii=2772. Available online: <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=2772>
16. Espié E., Vaillant V., Mariani-Kurkdjian P., Grimont F., Martin-Schaller R., De Valk H., Vernozy-Rozand C. (2006) *Escherichia coli* O157 outbreak associated with fresh unpasteurized goats' cheese. *Epidemiology and Infections*, Volume 134, 143-146.
17. Farina F., Fuser R., Rossi M., Scotton P. G. (2008) Outbreak di brucellosis nella provincial di Treviso da formaggio pecorina importato. *Le Infezioni in Medicina* n.3,154-157.
18. Fretz R., Pichler J., Sagel U., Much P., Ruppitsch W., Pietzka A.T., Stöger A., Huhulescu S., Heuberger S., Appl G., Werber D., Stark K., Prager R., Flieger A., Karpíšková R., Pfaff G., Allerberger F. (2010) Update: Multinational listeriosis

- outbreak due to ‘Quargel’, a sour milk curd cheese, caused by two different *L. monocytogenes* serotype 1/2a strains, 2009–2010. *Eurosurveillance*, Volume 15, Issue 16, 22 April 2010.
19. Fretz R., Sagel U., Ruppitsch W., Pietzka A.T., Stöger A., Huhulescu S., Heuberger S., Pichler J., Much P., Pfaff G., Stark K., Prager R., Flieger A., Feenstra O., Allerberger F. (2010) Listeriosis outbreak caused by acid curd cheese ‘Quargel’, Austria and Germany 2009 *Eurosurveillance*, Volume 15, Issue 5, 04 February 2010.
 20. Haeghebaert S., Sulem P., Deroudille L., Vanneroy-Adenot E., Bagnis O., Bouvet P., Grimont F., Brisabois A., Hervy C., Espié E., de Valk H., Vaillant V. (2003) Two outbreaks of *Salmonella enteritidis* phage type 8 linked to the consumption of Cantal cheese made with raw milk, France, 2001. *Eurosurveillance* 2003; 8(7):pii=419. Available online: <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=419>
 21. Holzmann H., Aberle S.W., Stiasny K., Werner P., Mischak A., Zainer B., Netzer M., Koppi S., Bechter E., Heinz F.X. (2009) Tick-borne encephalitis from eating goat cheese in a mountain region of Austria. *Emerging Infectious Diseases* 15: (10) 1671–1673.
 22. Honish L., Predy G., Hislop N., Chui L., Kowalewska-Grochowska K., Tottier L., Kreplin C., Zazulak I. (2005) An outbreak of *E.coli* O157:H7 hemorrhagic colitis associated with unpasteurised gouda cheese. *Canadian Journal of Public Health* 96:3: 182–185.
 23. Iaria C., Ricciardi F., Marano F., Puglisi G., Pappas G., Cascio A. Live nativity and brucellosis, Sicily. (2006). *Emerging Infectious Diseases* 12: (12) 2001–2002.
 24. Jaros P., Cogger N., French N. (2008) A systematic review of the human disease evidence associated with the consumption of raw milk and raw milk cheeses. A report prepared for the New Zealand Food Safety Authority. <http://www.foodsafety.govt.nz/elibrary/industry/systematic-review-human-research-projects/final-report-rawmilk.pdf>.
 25. Jennings G.J., Hajjeh R.A., Girgis F.Y., Fadeel M.A., Maksoud M.A., Wasfy M.O., Sayed N.E., Srikantiah P., Luby SP., Earhart K., Mahoney F.J. (2007) Brucellosis as a cause of acute febrile illness in Egypt. *Transactions of the Royal Society of Tropical Medicine and Hygiene* 101:707–713.
 26. Kansas Department of Health and Environment (2007) Outbreak of *Campylobacter jejuni* infections associated with consumption of cheese made from raw milk – Western Kansas 2007.

http://www.kdheks.gov/epi/download/Western_KS_OCT07_Campylobacter.pdf

http://www.kdheks.gov/epi/download/BU_RN_Campy_Nov07_final_report.pdf

27. Kuusi M., Lahti E., Virolainen A., Hatakka M., Vuento R., Rantala L., Vuopio-Varkila J., Seuna E., Karppelin M., Hakkinen M., Takkinen J., Gindonis V., Siponen K., Huotari K. (2006) An outbreak of *Streptococcus equi* subspecies *zooepidemicus* associated with consumption of fresh goat cheese. *BMC Infectious Diseases*. 2006; 6: 36. Published online 2006 February 27. doi: [10.1186/1471-2334-6-36](https://doi.org/10.1186/1471-2334-6-36).
28. MacCarthy T., Phan Q., Mshar P., Howard R., Hadler J.L. (2002) Outbreak of multidrug-resistant *Salmonella Newport* associated with consumption of Italian-style soft cheese, Connecticut. *International Conference on Emerging Diseases Atlanta Georgia USA*. Board 84 p 95.
29. MacDonald P. D. M., Whitwam R. E., Boggs J. D., MacCormack J. N., Anderson K. L., Reardon J. W., Saah J. R., Graves L. M., Hunter S. B., Sobel J. (2005) Outbreak of listeriosis among Mexican immigrants as a result of consumption of illicitly produced Mexican-style cheese. *Clinical Infectious Diseases* 40:677–82.
30. Makino S.-I., Kawamoto K., Takeshi K., Okada Y., Yamasaki M., S. Yamamoto, Igimi S. (2005) An outbreak of food-borne listeriosis due to cheese in Japan, during 2001. *International Journal of Food Microbiology* 104:189–196.
31. Mendez Martinez C., Paez Jimenez A., Cortés-Blanco M., Salmoral Chamizo E., Mohedano Mohedano E., Plata C., Varo Baena A., Martinez Navarro J.F. (2003) Brucellosis outbreak due to unpasteurised raw goat cheese in Andalusia (Spain), January–March 2002. *Eurosurveillance* 2003; 8(7):pii=421. Available online: <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=421>
32. Ostin A., De Buyser M.L., Guillier F., Groult J., Félix B., Salah S., Delmas G., Hennekinne J.A. (2010) First evidence of a food poisoning outbreak due to Staphylococcal enterotoxin type E, France, 2009. *Eurosurveillance*, Volume 15, Issue 13, 01 April 2010.
<http://www.eurosurveillance.org/images/dynamic/EE/V15N13/art19528.pdf>
33. Pastore R., Schmid H., Altpeter E., Baumgartner A., Hächler H., Imhof R., Sudre P., Boubaker K., (2008) Outbreak of *Salmonella* serovar Stanley infections in Switzerland linked to locally produced soft cheese, September 2006–February 2007. *Eurosurveillance* 2008;13 (37):pii=18979. Available online: <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=18979>

34. Public Health Agency of Canada (2003) First documented outbreak of *Listeria monocytogenes* in Quebec, 2002. *Canada Communicable Disease Report* Volume 29-21, 1 November 2003.
35. U.S. Food and Drug Administration. (2010) FDA news release: FDA, CDC, and Costco warn consumers to avoid Bravo Farms Dutch Style Gouda cheese. <http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm232748.htm>. See also CDC Investigation Update 24 November 2010.
36. U.S. Food and Drug Administration. (2010) FDA news release: FDA: Consumers should not eat Sally Jackson cheese due to risk of *Escherichia coli* O157:H7. <http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm237381.htm>
37. U.S. Food and Drug Administration. (2010) FDA Recall-Firm Press Release. Del Bueno amends recall of Queso Fresco cheese because of possible health risk. www.fda.gov/Safety/Recalls/ucm207627.htm
38. van Cauteren D., Jourdan-da Silva N., Weill F.X., King L., Brisabois A., Delmas G., Vaillant V., de Valk H. (2009) Outbreak of *Salmonella enterica* serotype Muenster infections associated with goat's cheese, France, March 2008. (2009) *Eurosurveillance* Volume 14, Issue 31, 6 August 2009.
39. van Duynhoven YTHP., Isken L. D., Borgen K., Besselse M., Soethoudt K., Haitisma O., Mulder B., Notermans DW., De Jonge R., Kock P., Van Pelt W., Stenvers O., Van Steenberghe J. (2009) A prolonged outbreak of *Salmonella typhimurium* infection related to an uncommon vehicle: hard cheese made from raw milk. *Epidemiology and Infections* 137, 1548–1557.
40. Washoe County (Nevada) May 2010 Press Release: Health district issues consumer advisory on illegal cheese. www.co.washoe.nv.us/repository/print_pr.php?article=8702.