# Outbreaks of Foodborne Illness Associated with Common Berries, 1983 through 2019[1]

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## Introduction

Fresh and frozen common berries (i.e., blackberries, blueberries, raspberries, and strawberries) are popular and healthy foods. When berries are picked for fresh consumption, they are either placed directly in retail containers in the field or packed in a packinghouse without washing because they are highly perishable. Berries may be washed before freezing, but they are not usually blanched or heat-treated unless they are used in preserves or other processed products. Thus, there is typically no "kill step" that would eliminate pathogens in fresh or frozen berries.

Berries may be served mixed with other foods, such as in salads or desserts, and these foods may contain more than one kind of berry or other fruit. Epidemiologists have more difficulty accurately determining the food vehicle during a foodborne illness outbreak when the outbreak is associated with mixed foods, such as mixed berries. The viral and parasitic pathogens that have caused outbreaks associated with consumption of berries are difficult to detect in foods. The laboratory methods used to detect these pathogens have only recently been developed or are still under development. In November 2018, FDA began a 2-year survey of frozen berries (strawberries, raspberries, and blackberries) for the presence of norovirus and hepatitis A. As of September 30, 2019, 812 samples (339 domestic and 473 imported) had been screened. Of the frozen berries sampled, genetic material from hepatitis A virus was found in five samples (three domestic: one strawberry, one raspberry, and one blackberry; two imported: two raspberry) and genetic material from norovirus in eight samples (three domestic: one strawberry, two raspberry; five imported: two strawberry, one raspberry, two blackberry). At the time of publication, testing is ongoing; the FDA's plan is to test 2,000 samples (1,000 domestic and imported each) over 2 years.

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This publication serves as a reference for anyone concerned about the safety of fresh and frozen berry products. Providing information for those who grow, harvest, process, transport, and serve berries to consumers is important for improving science-based food safety programs for the entire supply chain. Table 1 lists the reported outbreaks of foodborne illness from 1983 through 2019 in which specific berries or mixed berries have been identified as the food vehicle. Table 2 lists the reported outbreaks in which berries were *likely* the food vehicle.

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Table 1. Foodborne illness outbreaks associated with common berries as the food vehicle, 1983 through 2019.

| Berry | Form | Country of origin | Pathogen[1] | Year | Outbreak location | Number of cases (deaths[2]) | Isolated/ detected in product | Comments | References |
|---|---|---|---|---|---|---|---|---|---|
| Blackberry | NR[3] | NR | *C. cayetanensis* | 2013 | United States (Wisconsin) | 8 (0) | Yes | Consumed in private home | CDC 2018 |
| Blackberry | NR | NR | *C. cayetanensis* | 2017 | United States (Florida) | 6 (0) | Yes | | CDC 2018 |
| Blackberry | Fresh | NR | Hepatitis A | 2019 | United States (7 states) | 20 (0) | No | Source of contamination unknown | CDC 2020b |
| Blueberry | NR | NR | *Salmonella* Muenchen | 2009 | United States (multiple states) | 14 (0) | NR | Consumed in private home(s) | CDC 2018 |
| Blueberry | Fresh | United States (Georgia) | *Salmonella* Newport | 2010 | United States, Minnesota | 6 (0) | NR | Traced to single grower | CDC 2018; Miller et al. 2013 |
| Raspberry | Fresh | Guatemala | *C. cayetanensis* | 1996 | United States (multiple states), Canada (Ontario) | 850 | No | Source of contamination unknown | CDC 1996; Herwaldt and Ackers 1997 |
| Raspberry | Fresh | Guatemala | *C. cayetanensis* | 1997 | United States (multiple states), Canada (Ontario) | 1,012 (0) | No | Source of contamination unknown | CDC 1997b; CDC 1997c; Herwaldt and Beach 1999 |
| Raspberry | Fresh | Guatemala | *C. cayetanensis* | 1998 | Canada (Ontario) | 192 | No | Source of contamination unknown | CDC 1998 |
| Raspberry | Fresh | Guatemala (likely) | *C. cayetanensis* | 2000 | United States (Georgia, Pennsylvania) | 54 (0) | Yes (PCR[4]) | Source of contamination unknown | Ho et al. 2002; Murrow, Blake, and Kreckman 2002 |
| Raspberry | NR | NR | *C. cayetanensis* | 2002 | United States (Vermont) | 26 (0) | Yes | Suspected to be from Chile | CDC 2018; CDC 2019 |
| Raspberry | Frozen | East Europe | Calicivirus | 1988 | Finland | 509 | No | Source of contamination unknown | Pönkä et al. 1999a; Pönkä et al. 1999b |
| Raspberry | Frozen | Scotland | Hepatitis A | 1983 | Scotland | 24 | No | Pickers were believed to be the source of contamination; cases were reported in the area at the time of picking. | Reid and Robinson 1987 |
| Raspberry | Purchased fresh, then frozen | Scotland | Hepatitis A | 1988 | Scotland | 5 | No | Infection was confirmed in a picker at the farm; other pickers had been ill, some with jaundice. | Ramsay and Upton 1989 |
| Raspberry | Frozen pieces | Poland | Norovirus | 2005 | Denmark | 973 | No | Six point source outbreaks occurred between June and September; five of these linked to the same large batch of frozen raspberries, which came from several small farms in Poland. | Falkenhorst et al. 2005; Korsager et al. 2005 |

| Berry | Form | Country of origin | Pathogen[1] | Year | Outbreak location | Number of cases (deaths[2]) | Isolated/ detected in product | Comments | References |
|---|---|---|---|---|---|---|---|---|---|
| Raspberry | Frozen, imported | NR | Norovirus | 2005 | France | 75 | No | Raspberries blended with *fromage blanc*, and a frozen raspberry placed on each dessert by hand; kitchen staff did not report GI illness before the outbreak. | Cotterelle et al. 2005 |
| Raspberry | Frozen | China | Norovirus | 2006 | Sweden | 43 | NR | Four outbreaks between end of June and end of August in southwestern part of country; raspberries were same brand in each outbreak; lab results on leftover product were pending at time of report. | Hjertqvist et al. 2006 |
| Raspberry | Frozen | Poland (some batches) | Norovirus | 2009 | Finland | 900 | Yes | Thirteen outbreaks linked to consumption of imported raspberries; two positive batches, one of which traced back to 62 different farms; source of contamination not known. | Maunula et al. 2009; Sarvikivi et al. 2012 |
| Raspberry | Frozen | China | Norovirus | 2019 | United States | 323 | Yes | Three outbreaks between July and September on ships belonging to the same cruise line and traveling to the New York area from foreign ports. Raspberries, tropical fruit cocktail, and berry mix were all implicated; the source was determined to be frozen raspberries from the same lot from a supplier in China. | CDC 2020a |
| Strawberry | Frozen | United States (California) | Hepatitis A | 1990 | United States (Georgia, Montana) | 28 | No | Outbreaks in elementary school in Georgia and institution for disabled in Montana; molecular analysis of HAV from patients showed viral genomes genetically identical and distinct from other known US strains; strawberries implicated in both outbreaks processed at same plant on same night; infected picker was believed to be the likely source. | Niu et al. 1992 |
| Strawberry | Frozen | Mexico | Hepatitis A | 1997 | United States (Michigan, Maine) | 242 | No | Implicated strawberries were grown in Mexico, processed and frozen in California, and distributed through USDA school lunch programs and through distributors for commercial use; US FDA conducted site visits of growing fields and found inadequate toilet and handwashing facilities; workers did not wear gloves and removed berry calyx with fingernails. | CDC 1997a; Hutin et al. 1999 |
| Strawberry | Frozen | China | Norovirus | 2012 | Germany | 11,200 | NR | Berries delivered to almost 500 schools and day care centers in eastern Germany by catering firm | Associated Press 2012; Dw.de 2012; Bourquin 2012 |

| Berry | Form | Country of origin | Pathogen[1] | Year | Outbreak location | Number of cases (deaths[2]) | Isolated/ detected in product | Comments | References |
|---|---|---|---|---|---|---|---|---|---|
| Strawberry | NR | NR | Hepatitis A | 1998 | United States (Texas) | 29 | Yes | | CDC 2018 |
| Strawberry | NR | NR | Hepatitis A | 2000 | United States (Massachusetts) | 8 | Yes | | CDC 2018 |
| Strawberry | NR | NR | *Salmonella enterica* | 2003 | United States (California) | 13 | Yes | | CDC 2018 |
| Strawberry | NR | NR | Norovirus | 2005 | United States (Georgia) | 40 (0) | NR | Consumed at wedding reception | CDC 2018 |
| Strawberry | NR | NR | Norovirus | 2007 | United States (Georgia) | 10 (0) | NR | Consumed in private home | CDC 2018 |
| Strawberry | Fresh | NR | Norovirus | 2007 | United States (California) | 17 (0) | NR | Consumed with ice cream in restaurant | CDC 2018 |
| Strawberry | Fresh | United States | *E. coli* O157:H7 | 2011 | United States (Oregon) | 15 (2) | NR | Matching strain found by environmental sampling in field, including deer droppings | CDC 2018; Oregon Public Health 2011; Terry 2011 |
| Strawberry | NR | NR | Hepatitis A | 2013 | United States (Colorado) | 2 (0) | Yes | Consumed in private home | CDC 2018 |
| Berry mixture (pomegranate seeds, strawberry, blueberry, cherry) | Frozen | NR | Hepatitis A | 2012 | Canada (British Columbia) | 8 | NR | Five of 8 cases recalled eating this product | CFIA 2012; Marler-Clark 2012; Rothschild 2012 |
| Berries, mixed | NR | NR | *C. cayetanensis* | 2008 | United States (California) | 59 (0) | NR | Consumed at workplace cafeteria and banquet facility | CDC 2018 |
| Berries | NR | NR | *C. cayetanensis* | 2008 | United States (Tennessee) | 3 (0) | NR | Type of berry not described, consumed at banquet facility; outbreak occurred in same month (July) as California outbreak | Marler-Clark 2012; CDC 2013b |
| Berries | Frozen | NR | Hepatitis A | 2012–2013 | Denmark, Finland, Norway, Sweden | 64 | No | Investigations showed that frozen strawberries imported from North Africa as the most likely vehicle of the infection. An additional 42 probable cases are also documented. | ECDC-EFSA 2013a |
| Berries, mixed | Frozen | NR | Hepatitis A | 2013 | Germany, the Netherlands, Poland | 15 | Yes, in package from case patient's home | All cases had traveled to northern Italy, provinces of Trento and Bolzano. Hepatitis A subgenotype IB | ECDC-EFSA 2013b |

| Berry | Form | Country of origin | Pathogen[1] | Year | Outbreak location | Number of cases (deaths[2]) | Isolated/ detected in product | Comments | References |
|---|---|---|---|---|---|---|---|---|---|
| Berries, mixed (contained pomegranate seeds) | Frozen | Berries from United States, Chile, and Argentina; pomegranate seeds from Turkey | Hepatitis A | 2013 | United States (Arizona, California, Colorado, New Mexico, and Nevada) | 30 | Testing ongoing | Genotype 1B. Same genotype as outbreak in British Columbia (2012) and northern Europe (2012–2013). Genotype reported to be rare in the United States, but circulates in Middle East and North Africa. | Colorado Department of Public Health and Environment 2013; CDC 2013 |
| Raspberry and blackberry | NR | NR | *C. cayetanesis* | 1999 | United States (Florida) | 94 | Yes | Consumed at a restaurant | CDC 2018 |
| Raspberry and blackberry | NR | NR | *C. cayetanesis* | 2000 | United States (Georgia) | 19 (0) | Yes | Consumed at a restaurant | CDC 2018 |
| Raspberry and blackberry | NR | NR | *C. cayetanensis* | 2009 | United States (Connecticut) | 8 (0) | Yes | Consumed in private home | CDC 2018 |
| Strawberry and blueberry | NR | NR | *E. coli* O26 | 2006 | United States (Massachusetts) | 5 (0) | NR | | Luna and Mody 2010, CDC 2018 |

[1] Pathogen abbreviated as *C.* denotes *Cyclospora*.
[2] Deaths are shown in parentheses (x) only if reported by literature sources. If no (x) appears, no information on deaths was reported.
[3] NR, not reported
[4] PCR, polymerase chain reaction

Table 2. Foodborne illness outbreaks suspected to be associated with common berries as the food vehicle, 1983 through May 2019.

| Berry | Form | Country of origin | Pathogen[1] | Year | Outbreak location | Number of cases (deaths[2]) | Isolated/ detected in product | Comments | References |
|---|---|---|---|---|---|---|---|---|---|
| Blackberry likely | Fresh | Guatemala | *C. cayetanensis* | 1999 | Canada (Ontario) | 104 | No | Implicated dessert contained blackberries, frozen Chilean raspberries, fresh US strawberries | Herwaldt 2000 |
| Blackberry likely | Frozen | NR[3] | Norovirus | 2005 | Germany | 241 | No | [Article in German] | Fell, Boyens, and Baumgarte 2007 |
| Raspberry most likely (strawberry possible) | Fresh | Guatemala | *C. cayetanensis* | 1996 | United States (20 states and Washington, DC), Canada (2 provinces) | 1,465 (0) | No | Possible contamination due to fruit spraying with insecticides and fungicides mixed with contaminated water | Fleming et al. 1998; Herwaldt and Ackers 1997; Katz et al. 1999 |
| Raspberry likely | NR | Guatemala (likely) | *C. cayetanensis* | 1995 | Florida | 87 | No | Two social events; berries purchased from separate sources | Koumans et al. 1998 |
| Strawberry likely | NR | NR | *Cryptosporidium* | 2014 | United States (Ohio) | 6 (0) | No | Consumed in private home | CDC 2018 |

[1] Pathogen abbreviated as *C.* denotes *Cyclospora*.
[2] Deaths are shown in parentheses (x) only if reported by literature sources. If no (x) appears, no information on deaths was reported.
[3] NR, not reported