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Outbreaks of Foodborne Disease Associated with Fruit and Vegetable Juices, 1922–2010[1]

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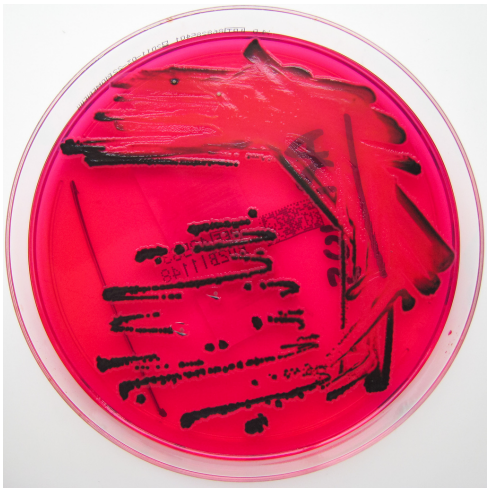
In response to several outbreaks of illness in the 1990s associated with raw juices processed at commercial facilities, the U.S. Food and Drug Administration (FDA) introduced regulation (21 Code of Federal Regulations 120; FDA, 2001) mandating that all 100% fruit/vegetable juices be produced under a Hazard Analysis and Critical Control Point (HACCP) plan. The juice HACCP regulation applies to domestic and imported 100% juice products and has implications for juice producers in countries that export juice to the United States.

HACCP plans must have supporting good manufacturing practices (GMPs) and sanitation standard operating procedures (SSOPs). In addition, the regulation requires juice processors apply a treatment that results in at least a 5-log reduction of the "pertinent microorganism," which is defined as "the most resistant microorganism of public health significance that is likely to occur in the juice." Identification of the pertinent microorganism for a particular juice may be based upon foodborne illness outbreak data or other appropriate information such as survey or recall reports involving isolation of pathogens from juices or the fruits or vegetables used to produce those juices. Currently, *Salmonella* is generally accepted as the pertinent pathogen in citrus juices, whereas *Escherichia coli* O157:H7 as well as *Cryptosporidium parvum* are both considered pertinent for apple juice (FDA, 2001). The juice HACCP regulation applies to domestic and imported 100% juice products and therefore has implications for juice producers in countries that export juice to the United States.

This document is intended to highlight juice-related outbreaks, aid juice processors in the identification of "pertinent microorganisms," and review the locations, venues of juice preparations, and severity of juice-associated outbreaks.



Salmonella species on X.L.D. agar
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Table 1. Outbreaks of human foodborne disease from various microorganisms associated with juices during the period of 1922–2010

Type	Product	Pathogen[a]	Year	Location	Venue	Cases (deaths)[b]	Reference[c]
Açaí	Unspecified	*Trypanosoma cruzi*[d]	2004	Brazil	Retail	27	SVS, 2005b; Pereira et al., 2009
	Unspecified	*Trypanosoma cruzi*	2007	Brazil	Retail	25	SVS, 2007b; Pereira et al., 2009
Apple	Unpasteurized	*S.* Typhi	1922	France	NR[e]	23 (0)	Paquet, 1923
	Unpasteurized	*S.* Typhimurium	1974	USA (NJ)	Farm, small retail outlets	296 (0)	CDC, 1975
	Unpasteurized	*E. coli* O157:H7 (suspected)	1980	Canada (ON)	Local market	14 (1)	Steele et al., 1982
	Unpasteurized	*E. coli* O157:H7	1991	USA (MA)	Small cider mill	23 (0)	Besser et al., 1993
	Unpasteurized	*Cryptosporidium*	1993	USA (ME)	School	213 (0)	Millard et al., 1994
	Unpasteurized	*C. parvum*	1996	USA (NY)	Small cider mill	31 (0)	CDC, 1997
	Unpasteurized	*E. coli* O157:H7	1996	USA (CT)	Small cider mill	14 (0)	CDC, 1997
	Unpasteurized	*E.coli* O157:H7	1996	USA (WA)	Small cider mill	6 (0)	FDA, 2001
	Unpasteurized	*E. coli* O157:H7	1996	Canada (BC), USA (CA, CO, WA)	Retail	70 (1)	CDC, 1996; Cody et al., 1999
	Unpasteurized	*E. coli* O157:H7	1997	USA (IN)	Farm	6	INS DOH, 1997
	Unpasteurized	*E. coli* O157:H7	1998	Canada (ON)	Farm/Home	14 (0)	Tamblyn et al., 1999
	Unpasteurized	*E. coli* O157:H7	1999	USA (OK)	NR	25	CDC, 2011
	Unpasteurized	*C. parvum*	2003	USA (OH)	Farm/Retail	144	Vojdani et al., 2008
	Unpasteurized	*E. coli* O111 and *C. parvum*	2004	USA (NY)	Farm/Home	212	Vojdani et al., 2008
	Unpasteurized	*E. coli* O157:H7	2005	Canada (ON)	NR	4	LSDEPC, 2005
	Unpasteurized	*E. coli* O157:H7	2007	USA (MA)	NR	9	CDC, 2011
	Unpasteurized	*E. coli* O157:H7	2008	USA (IA)	Fair	7	CDC, 2011
	Unpasteurized	*E. coli* O157:H7	2010	USA (MD)	Retail	7	FDA, 2010
Carrot	Homemade	*C. botulinum*	1993	USA (WA)	Home	1 (0)	Buzby and Crutchfield, 1999
	Pasteurized	*C. botulinum*	2006	USA	Retail	4	CDC, 2006
Coconut	Milk[f]	*Vibrio cholerae*	1991	USA (MD)	Home/picnic	4	CDC, 1991; Taylor et al., 1993
Guava	Unspecified	*Trypanosoma cruzi*	2007	Venezuela	School	103 (1)	Alarcón de Noya et al., 2010
Mamey	Frozen Puree	*S.* Typhi	1999	USA	NR	19	Katz et al., 2002
	Frozen Pulp	*S.* Typhi	2010	USA	Retail	9	CDC, 2010

Type	Product	Pathogen[a]	Year	Location	Venue	Cases (deaths)[b]	Reference[c]
Mixed Fruit	Unspecified	*Shigella sonnei*	2002	Canada, USA, UK, British West Indies	Resort	78	CDC, 2011
	Açaí, sugar cane	*Trypanosoma cruzi*	2006	Brazil	NR	94 (6)	SVS, 2007a; Pereira et al., 2009
	Acai, banana, strawberry, sugar cane	Hepatitis A	2007	USA (FL)	Food Service	3	CDC, 2011
Mixed Fruit / Vegetable	Clover, sweet potato leaf, apple	*Angiostrongylus cantonesis*[g]	2001	Taiwan	Home	5	Tsai et al., 2004
Orange	Unpasteurized	Enterotoxigenic *E. coli*	1992	India	Roadside vendor	6 (0)	Singh et al., 1995
	Unpasteurized	*Salmonella* Gaminera, Hartford and Rubislaw	1995	USA (FL)	Retail	63 (0)	CDC, 1995; Cook et al., 1998; Parish, 1998
	Unpasteurized	*Shigella flexneri*	1995	South Africa	Restaurant	14	Thurston et al., 1998
	Unpasteurized	Virus suspected	1996	USA	Food Service	2	Parish, 2000
	Unpasteurized	*S.* Muenchen	1999	Canada and USA	Restaurant	423 (1)	CDC, 1999
	Unpasteurized	*S.* Anatum	1999	USA (FL)	Roadside stand	6 (0)	Krause et al., 2001
	Unpasteurized	*S.* Typhimurium	1999	Australia	Retail	405 (0)	National Centre for Disease Control, 1999
	Unpasteurized	*S.* Enteritidis	2000	USA (6 states)	Retail and Food Service	88	Butler, 2000
	Unpasteurized	*Salmonella* Typhimurium and Saintpaul	2005	USA (23 states)	Retail and Food Service	152	Jain et al., 2009
	Reconstituted	*S.* Typhi	1944	USA (OH)	Hotel	18 (1)	Duncan et al., 1946
	Reconstituted	Hepatitis A	1962	USA (MO)	Hospital	24	Eisenstein et al., 1963
	Reconstituted	Unknown	1965	USA (CA)	Football game	563	Tabershaw et al., 1967
	Reconstituted	*S.* Typhi	1989	USA (NY)	Hotel	69	Birkhead et al., 1993
	Unspecified	Norwalk-like virus	1991	Australia	Airline	3,053	Lester et al., 1991
Sugar cane	Unspecified	*Trypanosoma cruzi*	2005	Brazil	Roadside kiosk	25 (3)	SVS, 2005a; Pereira et al., 2009
Watermelon	Homemade	*Salmonella* spp	1993	USA (FL)	Home	18 (0)	FDA, 1998

Type	Product	Pathogen[a]	Year	Location	Venue	Cases (deaths)[b]	Reference[c]

[a]Pathogens abbreviated and associated with outbreaks include *S. – Salmonella; E. – Escherichia; C. parvum – Cryptosporidium parvum; C. botulinum – Clostridium botulinum.*
[b]The number in parenthescs represents the number of deaths if reported.
[c]References for each outbreak appears in the following reference list.
[d]*Trypanosoma cruzi* is the causative agent of Ch_gas bisease.
[e]NR – Not Reported
[f]Coconut milk is the liquid that is squeezed from the coconut meat; coconut juice or coconut water is the liquid obtained from a whole coconut when one breaks the shell.
[g]*Angiostrongylus cantonensis*, also known as rat lungworm, is the major cause of eosinophilic meningitis in the Pacific Islands and southeast Asia.

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