

## Sesame seed products contaminated with *Salmonella*: three outbreaks associated with tahini

L. E. UNICOMB<sup>1</sup>, G. SIMMONS<sup>2</sup>, T. MERRITT<sup>1\*</sup>, J. GREGORY<sup>3</sup>, C. NICOL<sup>4</sup>,  
P. JELFS<sup>5</sup>, M. KIRK<sup>6</sup>, A. TAN<sup>7</sup>, R. THOMSON<sup>8</sup>, J. ADAMOPOULOS<sup>9</sup>,  
C. L. LITTLE<sup>10</sup>, A. CURRIE<sup>11</sup> AND C. B. DALTON<sup>1</sup>

<sup>1</sup> OzFoodNet, Hunter Population Health, Wallsend, New South Wales (NSW), Australia

<sup>2</sup> Auckland Regional Public Health Service, Auckland, New Zealand

<sup>3</sup> Victorian Department of Human Services, Melbourne, Victoria, Australia

<sup>4</sup> Enteric Reference Laboratory, Institute of Environmental Science and Research Ltd (ESR)  
Kenepuru Science Centre Porirua, New Zealand

<sup>5</sup> Institute of Clinical Pathology and Medical Research, Westmead, NSW, Australia

<sup>6</sup> OzFoodNet, Department of Health and Ageing, Canberra, Australia

<sup>7</sup> Microbiological Diagnostic Unit Public Health Laboratory, University of Melbourne, Parkville,  
Victoria, Australia

<sup>8</sup> New South Wales Food Authority, Silverwater, NSW, Australia

<sup>9</sup> OzFoodNet, Victorian Department of Human Services, Melbourne, Victoria, Australia

<sup>10</sup> Health Protection Agency Communicable Disease Surveillance Centre, London, UK

<sup>11</sup> Foodborne, Waterborne and Zoonotic Infections Division, Health Canada, Guelph, Ontario, Canada

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### SUMMARY

In November 2002, the first of three outbreaks of *Salmonella* Montevideo infection in Australia and New Zealand was identified in New South Wales, Australia. Affected persons were interviewed, and epidemiologically linked retail outlets inspected. Imported tahini was rapidly identified as the source of infection. The contaminated tahini was recalled and international alerts posted. A second outbreak was identified in Australia in June–July 2003 and another in New Zealand in August 2003. In a total of 68 *S.* Montevideo infections, 66 cases were contacted. Fifty-four (82%) reported consumption of sesame seed-based foods. Laboratory analyses demonstrated closely related PFGE patterns in the *S.* Montevideo isolates from human cases and sesame-based foods imported from two countries. On the basis of our investigations sesame-based products were sampled in other jurisdictions and three products in Canada and one in the United Kingdom were positive for *Salmonella* spp., demonstrating the value of international alerts when food products have a wide distribution and a long shelf life. A review of the controls for *Salmonella* spp. during the production of sesame-based products is recommended.

### INTRODUCTION

*Salmonella* Montevideo is a rare serotype in Australia and New Zealand, with between 9 and 27 notified

cases per year, comprising 0·2–0·4% of the annual *Salmonella* isolates between 1995 and 2001, in Australia [1] and between 4 and 21 notified cases (0·3–1·0%) of *Salmonella* isolates annually for the same period in New Zealand (Enteric Reference Laboratory Data, ESR, Porirua, NZ). Due to the rarity of *S.* Montevideo in Australia and

\* Author for correspondence: Dr T. Merritt, Hunter Population Health, Locked Mailbag 10, Wallsend, NSW 2287, Australia.  
(Email: tony.merritt@hnehealth.nsw.gov.au)

New Zealand, local increases are easily detected by serotype surveillance.

*S. Montevideo* has caused outbreaks in the past. In the United States, outbreaks in 1995 and 1996 were attributed to 'mail order' baby chicks [2]. Outbreaks from Japan [3], the United Kingdom [4, 5] and the United States [6] have implicated salmon, cooked chicken and uncooked tomatoes.

*Salmonella* outbreaks associated with sesame seed-based products have been reported. In 2001 an outbreak of *S. Typhimurium* DT104 due to contaminated helva was detected in Sweden [7] and subsequently in Australia. Various *Salmonella* serotypes ( $n=16$ ), including *S. Montevideo*, have been detected in sesame-based products tested in Australia between 1984 and 2003 [1]. Such products are commonly produced in Middle Eastern countries such as Lebanon, Egypt, and Cyprus and have wide international distribution. These products are usually stored at room temperature and have a shelf life in the order of 2 years.

We describe the investigation of two outbreaks in Australia and one in New Zealand associated with imported sesame-based products. The first outbreak, which began in November 2002 in New South Wales (NSW), Australia, was detected through routine surveillance of human salmonellosis (outbreak 1). Cases with this uncommon serotype were interviewed, and a kebab outlet in common was identified and inspected. *S. Montevideo* was detected in hommus, a paste consisting of mashed cooked chick peas, garlic, lemon juice and tahini sauce at this retail outlet. The source of the *Salmonella* was traced to tahini, a paste made from crushed sesame seeds, and contaminated batches were recalled. Information on the recall of the implicated batches of tahini imported from Egypt was sent as an international alert via ProMED and FS-Net. In June–July 2003 and August 2003 further outbreaks of *S. Montevideo* infection were detected in Victoria, Australia (outbreak 2), and Auckland, New Zealand (outbreak 3). *S. Montevideo* was also detected in sesame-based products imported from Lebanon into Australia and New Zealand, leading to further product recalls. This report describes the epidemiological and environmental investigations of these *S. Montevideo* outbreaks. In addition, data on contaminated tahini detected in the United Kingdom and Canada from September to November 2003 are summarized.

## METHODS

### Epidemiological investigations

#### Case definitions

*Outbreak 1.* A case was defined as any person reported to the health authorities with *S. Montevideo* detected in their faecal sample, who had acquired their infection in Australia between 1 November 2002 and 31 March 2003.

*Outbreak 2.* A case was defined as any person notified to the Department of Human Services, Victoria, Australia as infected with *S. Montevideo* with symptom onset between 25 June and 29 July 2003.

*Outbreak 3.* A case was defined as any person reported to public health authorities in Auckland, New Zealand as infected with *S. Montevideo* with symptom onset between 8 August and 8 September 2003.

#### Case follow-up

Health agencies in each jurisdiction interviewed cases, each using standard questionnaires. Investigators obtained demographic and clinical information, and asked about food exposures in the 4 days prior to onset in Auckland, 7 days prior in NSW and for 2 weeks prior to illness onset in Victoria. Cases that did not have a clear onset date were asked about exposures in the week prior to specimen collection. In particular, cases were asked about consumption of foods containing tahini and/or sesame-based products, kebab sandwiches (pita bread containing spit-roasted meats, salad, and pastes such as hommus), and other Middle Eastern foods.

### Environmental investigations

Cases identified a range of retail outlets from which they had purchased foods containing tahini or other sesame seed-based products. Most were takeaway outlets selling kebab sandwiches and dips. Two grocery stores were also identified. These implicated retail outlets were investigated, and selected foods and ingredients were sampled in all three outbreak investigations. Samples were taken from containers of unopened tahini, opened 'in use' tahini, and ready to eat hommus.

### Laboratory investigations

Food samples were analysed by the Australian Standard method for *Salmonella* in food (AS 1766

series). Food and human *Salmonella* isolates were identified by conventional biochemical and serological techniques using the Kauffman–White scheme [8]. Selected *S. Montevideo*-positive food samples from outbreak 3 were analysed quantitatively, at the Institute of Environmental Science and Research Ltd in New Zealand, by the Most Probable Number (MPN) method [9].

*S. Montevideo* isolates from food and humans from Australia and New Zealand were characterized by pulsed field gel electrophoresis (PFGE) using the enzyme *Xba*I [10]. Gels were run on a ChefMapper (Bio-Rad, Hercules, CA, USA) for 22 h, 200 V (6 V/cm), linear rampage 5–50 s. Isolates tested included those from outbreaks 1, 2 and 3, as well as from nine unrelated human infections from NSW from 2001 and 2002, and 19 unrelated New Zealand isolates from 2000 to 2003 from human, veterinary and environmental sources. Representative images were sent to the Health Protection Agency (HPA), United Kingdom and Centers for Disease Control, Atlanta, for comparison with patterns available on the HPA and PulseNet databases.

### International investigations

Summaries of the food testing findings and resultant food recalls from this investigation were posted on ProMED and FS-Net on 8 January 2003 and 7 April 2003 respectively and *Eurosurveillance Weekly* on 18 September 2003. As a result of these alerts, microbiological surveys of tahini were undertaken in the United Kingdom and Canada.

## RESULTS

### Epidemiological investigations

#### *Human infection*

The three outbreaks comprised a total of 68 cases between November 2002 and September 2003 (Fig. 1), of which 66 were interviewed. Three cases from outbreak 1 did not have diarrhoea (Table 1). Two of these had submitted routine stool samples as part of ongoing bowel disturbance investigations, and one for investigation for parasites following prolonged travel abroad. In outbreak 1, three cases of *S. Montevideo* infection were notified outside of NSW during the outbreak period. All three had travelled to NSW during the incubation period.

#### *Exposure to sesame-based products*

Of the 66 interviewed cases, 54 (82%) reported consumption of a sesame-based product within the exposure period of the respective jurisdictions. Most had consumed kebab sandwiches containing hummus. In outbreak 1, 43 cases reported consumption of a sesame-based product of which 39 consumed kebab sandwiches containing hommus, one ate a falafel with hommus, and the others consumed hommus dip. Of the 54 persons who reported eating a sesame-based product, 49 identified a retail outlet that had used one of the three brands (A, B or C) of *S. Montevideo*-contaminated tahini.

In outbreak 1, 10 (18.9%) of the 53 persons interviewed ate a sesame-based product more than 1 week after that product had been recalled, and three others more than 2 months after the recall. The retail outlets involved were inspected. One outlet was reportedly unaware of the recall and was still selling the recalled product. Another outlet was using a recalled product that had been repackaged and relabelled. A third outlet had been preparing hommus from tahini not under recall but had combined this with leftover hommus made from Brand A tahini.

Two of the contaminated products associated with cases were positive for other *Salmonella* serotypes in addition to *S. Montevideo*. *S. Tennessee* was isolated from Brand A tahini implicated in outbreak 1. In NSW there were two cases of *S. Tennessee* infection during the period of outbreak 1; one case could not be contacted and the other did not report consuming sesame-based products. *S. Orion* var. 15+ was isolated from Brand C tahini implicated in outbreak 3. In New Zealand, one reported case of *S. Orion* 15+ occurred in July 2003 but was lost to follow-up.

### Environmental investigation

#### *Sesame-based products*

In outbreak 1, four of the first five cases had consumed kebab sandwiches at the same retail outlet. *S. Montevideo* was isolated from hommus and Brand A tahini which had been used to prepare the hommus in this outlet. Outbreak 1 cases identified a total of 11 retail outlets from which a sesame-based product had been purchased. All were inspected and eight were found to have used Brand A tahini, originating from Egypt. Unopened tahini obtained from the wholesaler was also positive for *S. Montevideo*.

Table 1. Characteristics of *S. Montevideo* outbreak cases, November 2002 to September 2003 in Australia and New Zealand

State/region, country	Outbreak no.		
	1 NSW, Australia	2 Victoria, Australia	3 Auckland, New Zealand
Number of cases	55	3	10
Response rate (%)	96	100	100
Reported consumption of sesame seed-based products* (%)	81	100	80
Incubation period (days)†			
Range	1–9	2–3	1–4
Median	2	2.5	2
Symptom frequency (%)			
Diarrhoea	89	100	100
Stomach cramps	85	100	90
Nausea	53	67	60
Vomiting	30	0	40
Fever	55	0	80
Other‡	34	100	40
Proportion hospitalized (%)	9	0	20
Illness duration (days)§			
Range	2–30	4–6	4–10
Median	6	5	5.5
Gender (%)			
Male	45	67	30
Case age (years)			
Range	0–71	18–49	3–62
Median	32	24	28.5

\* All brands of sesame seed-based products included.

† Information provided when cases recalled the dates of consumption of sesame seed product, based on time from consumption of sesame-based product.

‡ Headache, myalgia, arthralgia, lethargy, anorexia, pancreatitis (relapse), neck stiffness, bloating.

§ Among 48, 2, and 10 cases recalling duration from outbreaks 1, 2 and 3 respectively.

In outbreak 2, cases identified a single retail outlet that was using Brand B tahini originating from Lebanon.

In outbreak 3, cases identified a total of three retail outlets, all of which were found to have used Brand C tahini originating from Lebanon. Brand B and Brand C tahini were from the same company.

No food safety failures were identified in any of the retail outlets and in particular no time-temperature abuse of hommus was observed.

#### Product recalls

Sesame-based products identified in outbreaks 1, 2 and 3 that were positive for *S. Montevideo* were

recalled (Table 2). Brand A tahini was subject to a trade level recall (product is removed from sale, and recovered from distribution centres or wholesalers), Brand B to a trade level withdrawal (product is withdrawn from distribution by distribution centre or wholesaler) and Brand C, a consumer level recall (product is recovered from all points in the production and distribution networks including from consumers). In NSW, 16.7 tonnes of Brand A tahini were returned and destroyed. In New Zealand, over 3 tonnes of Brand A tahini, 284 kg of Brand B tahini, 17 kg of Brand B helva, and 1465 kg of Brand C tahini, were returned and destroyed. In Victoria, information on the amount of Brand B tahini and helva that was returned and destroyed was not recorded. In

Table 2. Summary of sesame seed-based product recalls and associated human cases of *S. Montevideo*, November 2002 to September 2003 in Australia and New Zealand

Importing country	Sesame seed-based product*	Brand name	Country of origin	Method of product identification	Recall date	Human cases linked to recalled product			
						Onset dates	No.	State/Region	PFGE profile†
Australia (outbreak 1)	Tahini‡	Brand A	Egypt	Outbreak cases	Dec. 2002	Nov. 02 to Apr. 03	39	NSW	1 (food and cases) J1XX01.0011
Australia (outbreak 2)	Tahini	Brand B	Lebanon	Routine sampling by large commercial caterer	Aug. 2003	June to July 03	2	Victoria	1 (food and cases) J1XX01.0011
New Zealand (outbreak 3)	Tahini§	Brand C	Lebanon	Outbreak cases	Aug. 2003	Aug. 03	8	Auckland	1 (food and cases) J1XX01.0011
Australia	Helva	Brand B	Lebanon	Lab. survey	Apr. 2003	n.a.	0	n.a.	2
New Zealand	Tahini	Brand A	Egypt	Sampling by commercial food business	July 2003	n.a.	0	n.a.	1 J1XX01.0011
New Zealand	Helva	Brand B	Lebanon	Same brand as contaminated tahini	Sept. 2003	n.a.	0	n.a.	1 J1XX01.0011

n.a., Not applicable.

\* All products contaminated with *S. Montevideo*.

† Arbitrary PFGE number assignment and CDC-PulseNet assignment of PFGE profiles provided.

‡ Product also contaminated with *S. Tennessee*.

§ Product also contaminated with *S. Orion* var. 15+.

In addition to these, a further four sesame-based products that were not linked to human cases were positive for *S. Montevideo* during 2003, three in Victoria and one in New Zealand. This resulted in further recalls in Australia and New Zealand (Table 2). In Victoria, the products were detected as part of a laboratory survey of high-risk imported foods that tested 86 samples. All three positive samples were Brand B products. In New Zealand, Brand A tahini was found to be contaminated with *S. Montevideo* during a risk assessment conducted on raw ingredients by a food processor as part of a food safety programme. As part of the sampling investigation of outbreak 3, two out of four Brand B and six out of 13 Brand C tahini samples were *Salmonella*-positive. In tests on the contaminated products from outbreak 3, the concentrations of *S. Montevideo* in tahini (eight samples), hommus and helva (one sample each) ranged from an MPN of <0.03–0.46 organisms/g.

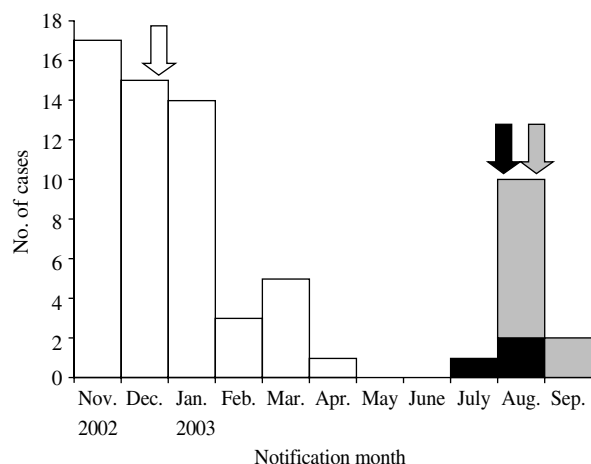
### Laboratory investigations

PFGE was performed on human and food isolates from outbreaks 1, 2 and 3 (Fig. 2), the patterns shown

in Figure 2 are representative of outbreaks 1 and 3. All patterns from cases and food were closely related with no more than a one-band shift observed. The patterns found in the human and food isolates for these outbreaks in both Australia and New Zealand were closely related to pattern J1XX01.0011, the most common pattern in the PulseNet database (B. Swaminathan, personal communication, June 2003). Four different pulsed field profiles were identified among nine sporadic *S. Montevideo* isolates detected between 2001 and 2002 from NSW, all were different from the outbreak profile, J1XX01.0011. Six different profiles were identified among 19 New Zealand sporadic isolates collected between 2000 and 2003, all distinct from J1XX01.0011. No antibiotic resistant strains were detected.

### International investigations

In the United Kingdom, three sesame seed-based products, two from Lebanon and one from Cyprus, were the subject of a recall in September and October 2003. Of 97 tahini samples tested as part of a public health investigation in the United Kingdom,

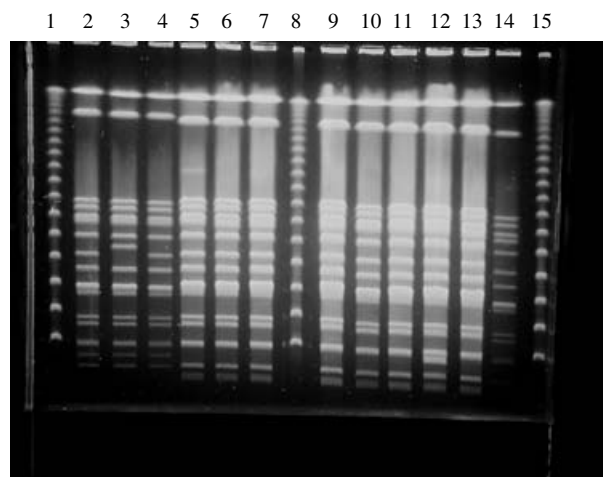


**Fig. 1.** *Salmonella* Montevideo cases in Australia and New Zealand by month of notification for outbreaks 1, 2 and 3. Arrows indicate recall date for the product associated with each outbreak. □, Outbreak 1 (NSW, Australia); ■, outbreak 2 (Victoria, Australia); ▒, outbreak 3 (Auckland (New Zealand)).

30 (31%) from three different manufacturers in Lebanon and Cyprus were contaminated with *Salmonella*, and five different serotypes were identified (Cubana, Lille, Mbandaka, Senftenberg, Tennessee), but not *S. Montevideo*. All the contaminated samples were tahini and were recalled at the trade level. Consumers were advised to discard any purchased product. In Canada, three batches of the same brand of tahini imported from Lebanon were subject to a consumer level recall in November, 2003. No human illnesses were associated with these products in Canada, although, product testing indicated the batches were contaminated with *Salmonella* including serotypes Cubana, Lille, and Tennessee.

## DISCUSSION

This report describes three outbreaks of *S. Montevideo* due to consumption of contaminated tahini. Of 66 infected persons interviewed, 82% reported eating foods containing tahini between 1 and 9 days before illness. Outbreaks 1 and 3 were identified through *Salmonella* serotype surveillance, and outbreak 2 was identified after health authorities were alerted when a contaminated food was detected during routine testing. Only cases of *S. Montevideo* infection were found linked to these products, despite *S. Tennessee* and *S. Orion* var. 15+ also being detected in some of the *S. Montevideo*-contaminated sesame-based products.



**Fig. 2.** PFGE profiles of *Xba*I-digested genomic DNA from isolates of *S. Montevideo* from sesame seed-based products and patients, November 2002 to September 2003 in Australia and New Zealand. Lanes 1, 8, 15, lambda ladder 50–1000 kb; lane 2, human, Australia; lanes 3, 4, tahini, Brand A, Australia; lane 5, human, New Zealand; lanes 6, 7, 9, 11, 14, tahini, Brand C, New Zealand; lane 12, tahini, Brand B, New Zealand; lane 10, hommus made from Brand C tahini, New Zealand; lane 13, helva made from Brand B, New Zealand. Voltage, 6 V/cm; ramp, 5–50 s; duration, 22 h; 1% agarose.

Although an analytical study was not performed our conclusion that sesame-based products were the source of infection is well supported. In outbreak 1 a contaminated sesame-based food was rapidly identified, cases of this rare serotype were easily detected and a high proportion of early cases reported consumption of sesame-based products. Furthermore, the association was strengthened by the fact that the same type of product was implicated in three outbreaks over a period of around 1 year. Moreover, after products were recalled, there were no further cases identified except those that were linked to retail outlets where recall had not been executed effectively.

A total of 18% of cases from the three outbreaks did not report consumption of sesame seed-based products. This may be explained by failure to recognize foods that may have contained a sesame-based product or by the incubation period being longer than the exposure period examined at interview. Different exposure periods were used for each of the three outbreaks, ranging from 4 to 14 days. There was evidence of a long incubation period [7/53 (13%) cases from outbreak 1 had onset > 5 days after consumption of a sesame seed-based product], possibly due to low numbers of *Salmonella* in the tahini. Enumeration on the products associated with outbreak 3 showed low

level contamination with *S. Montevideo*. Additionally, some cases may have resulted from secondary transmission or possibly cross-contamination at the retail outlet. The PFGE profiles of isolates tested from the outbreak periods were closely related, suggesting that all cases identified during this period had a common source of infection.

There have been previous reports of salmonellosis associated with consumption of sesame-based products. An international outbreak of *S. Typhimurium* DT104 infection was associated with consumption of helva [11], and a large outbreak of multiple *Salmonella* serotypes (Brandenburg, Mbandaka, Senftenberg, Oranienburg) was associated with consumption of kebab sandwiches containing tahini in New York in 1995 (C. Braden, personal communication, June 2004). In the New York outbreak the tahini tested positive for *S. Mbandaka*. In September 2000 a cluster of *S. Montevideo* infection was detected in New Zealand, with 11 laboratory-confirmed cases. A Middle Eastern food outlet was implicated in all cases and a food handler working on site was found to be excreting *S. Montevideo* of the same PFGE profile. It was not clear how the food handler became infected.

Exactly when and how the tahini batches implicated in these outbreaks became contaminated is unknown. A laboratory study of sesame-based products was recently conducted in Germany [12]. As part of the report an audit of tahini and helva processing determined that de-hulled seeds were usually heated to 120 °C prior to being milled. The authors reported that 12.5% of de-hulled sesame seed samples were positive for *Salmonella* and suggested that this may indicate contamination during harvesting [12]. Tahini is a Middle Eastern product, although the seeds are not grown in this area. It is possible that seeds used to make the product in different countries came from the same source, and that *Salmonella* survived processing. This is plausible as tahini is a low-moisture product and the conditions for bacterial destruction in such a product would be similar to those required for dry-heat sterilization (170 °C for 1½ hours). The PFGE results support this hypothesis with three products from two countries contaminated with the same serotype demonstrating closely related PFGE patterns. The origin of the seeds for Brands A, B and C tahini was not determined.

These investigations demonstrated the value of good descriptive epidemiological evidence in conjunction with microbiological confirmation of the

vehicle and molecular biological findings linking cases to the vehicle. Furthermore, PFGE patterns can be transmitted for comparison with patterns from isolates elsewhere which is particularly relevant in investigations involving a food product with global distribution and a long shelf life. The investigation also highlighted the limitations of trade level recalls that relied on notification of retail proprietors by a wholesaler. Cases from outbreak 1 were found to consume foods containing Brand A tahini after the food recall.

The association of salmonellosis with consumption of tahini has resulted in a policy change with the introduction of routine testing of imported sesame-based products in Australia. In New Zealand, under an emergency food standard, all sesame seed-based products must be tested for *Salmonella* before being cleared at the border. Routine testing of sesame-based products should be considered by agencies elsewhere. However, the point at which these products become contaminated with *Salmonella* is unknown and the production of tahini needs to be further assessed using HACCP principles [13]. Because of the possibility that low-level *Salmonella* contamination may go undetected by testing at the time of importation, the application of appropriate controls to prevent cross-contamination and the use of sufficient heat treatment are likely to be the most effective strategies to reduce risk to consumers.

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