An Outbreak of Typhoid Fever in Florida Associated with an Imported Frozen Fruit

Dolores J. Katz, 1 Miguel A. Cruz, 1, a Mary Jo Trepka, 1
Juan A. Suarez, 2 Paul D. Fiorella, 4
and Roberta M. Hammond 5

An outbreak of typhoid fever in Florida involving at least 16 persons during the winter of 1998–99 was investigated using case-control, environmental, and laboratory methods. The genomic profiles of Salmonella serovar Typhi (Salmonella Typhi) isolates from the 15 confirmed case subjects were identical. Consumption of fruit shakes made with frozen mamey, a tropical fruit, was significantly associated with illness (matched odds ratio, 7.6; 95% confidence interval, 1.4–81.4). Laboratory testing showed that the fruit was heavily contaminated with fecal coliforms; no Salmonella Typhi was isolated. The frozen mamey was prepared in plants in Guatemala and Honduras. No further cases occurred after the frozen product was recalled.

As our nation’s food sources become increasingly globalized, the risk of outbreaks of exotic diseases linked to contaminated imported food will increase. This outbreak highlights the need for new approaches to ensure the safety of our food supply.

The globalization of food markets has produced a new source of exotic disease outbreaks in the United States: commercially imported foods from developing nations [1–6]. In the winter of 1998–1999, typhoid fever was diagnosed in 16 Florida residents, only 1 of whom had engaged in foreign travel during the incubation period. We report the results of an investigation that implicated mamey, a commercially processed frozen fruit from Guatemala, as the probable source of the outbreak. This is the first known report of a typhoid fever outbreak in the United States caused by a commercially imported food.

Subjects, Materials, and Methods

Background

Typhoid fever, caused by Salmonella serovar Typhi (Salmonella Typhi), is spread by food and water contaminated by the feces or urine of infected persons; 2%–5% of those infected become chronic carriers. Worldwide, an estimated 17 million cases of typhoid fever and 600,000 fatalities caused by the disease occur annually [7]. With the provision of clean water and adequate sewage treatment to virtually the entire population, typhoid fever has become a rare disease in the United States. The annual rate has been <1 case/100,000 population for >20 years [8, 9]. Most of the average of 400 cases reported annually in the United States have been from travelers to countries where the disease is endemic [7, 10].

Identification of the Outbreak

From 11 January–5 February 1999, local hospitals reported 6 patients with typhoid fever to the Miami–Dade County Health Department. All were Hispanic, all were county residents, none was acquainted, and none had traveled outside the United States in the month before onset of illness. Fifty-seven percent of Miami-Dade County’s 2.1 million residents are Hispanic (US Census Bureau 1998 midyear population estimate; available at http://www.census.gov/population/estimates/county/crh/crh98.txt). Since 1990, Miami-Dade County had recorded an average of <1 case of typhoid fever per month in persons who did not engage in foreign travel. On 9 February, the Florida Department of Health’s central laboratory in Jacksonville completed pulsed-field gel electrophoresis (PFGE) of isolates from 3 of the patients. The laboratory reported that the isolates were indistinguishable and matched an isolate from a sev-
enth case reported in December 1998 from Pinellas County, 250 miles to the northwest.

On 10 February, the Miami-Dade County Health Department alerted area hospitals and physicians and neighboring county health departments. Hospital infection control practitioners were asked to review their patient logs for any Salmonella infections diagnosed from November 1998 through February 1999 that had not been reported to the health department. Hospital laboratories were asked to send all serogroup D Salmonella isolates (which includes Salmonella Typhi) identified since November 1998 to the Florida Department of Health's central laboratory for serotyping.

Laboratory Procedures

Identification of case subjects and PFGE analysis. Hospital laboratories that identified patients with Salmonella Typhi infections forwarded isolates from stool or blood cultures to the state's central laboratory. The central laboratory identified Salmonella Typhi with biochemical tests conducted according to standard methods, followed by serotyping of the O (somatic), Vi (capsular), and H (flagellar) antigens [11, 12].

The central laboratory performed PFGE on available Salmonella Typhi isolates. The DNA was prepared by a standard method and was digested with SpeI and XbaI (Promega) [13, 14].

The Centers for Disease Control and Prevention (CDC) posted the PFGE patterns on PulseNet, the US/Canadian network of public health laboratories established to improve surveillance for Escherichia coli O157:H7 and other important foodborne pathogens and to identify clusters that may represent outbreaks (available at http://www.cdc.gov/pulsenet) [15].

Testing of food samples. Samples of implicated products were sent to 3 public health laboratories: the Florida Department of Health's (DOH) central laboratory, the Florida Department of Agriculture and Consumer Service's (DACS) food laboratory, and the US Food and Drug Administration's (FDA) Southeast Regional Laboratory in Atlanta. All 3 laboratories used standard methods to identify fecal contamination, including tests for fecal coliforms and E. coli [16]. The 3 laboratories tested for Salmonella species and/or Salmonella Typhi using standard biochemical methods, and the DOH and DACS tested using ELISA-like methods [17, 18].

Epidemiologic Investigation

Case definition. For the outbreak investigation, a confirmed case was defined as a febrile illness with onset after 31 October 1998 in any Florida resident with a stool, blood, or urine culture from which the state central laboratory identified Salmonella Typhi. A probable case was a febrile illness in any Florida resident with onset during the same period and a stool, blood, or urine culture from which any other laboratory identified Salmonella Typhi.

Preliminary investigation. Case subjects initially were interviewed with a standard typhoid fever questionnaire to identify any common risk factors, including foods, restaurants or grocery stores, water sources, day care centers, community events, and personal contacts. No common sources were identified. In unstructured interviews, 3 of the case subjects mentioned consumption of fruit shakes (batidos) made with mamey. Batidos, popular in the Hispanic community, usually are made with milk, ice, fruit, and, sometimes, sugar. Mamey (also called zapote) is a tropical fruit with a sweet, distinctive taste. Subsequently, 11 case subjects were re-interviewed and asked open-ended questions about fruit and beverage consumption; 10 said they had drunk mamey batidos. A case control study was designed to test the hypothesis that consumption of mamey was associated with Salmonella Typhi infection.

Case-Control Study

The Florida Department of Health conducted a case-control study that sought to match each confirmed or probable case subject with 4 control subjects of the same age group and ethnic background. If the case or control subject was aged <6 years, the child’s parents were interviewed. If the case or control subject was aged 6–17 years, the interviewer questioned the child directly after obtaining parental consent. Trained telephone interviewers fluent in Spanish and English interviewed case subjects and their matched control subjects in the case subject’s preferred language, using a standard questionnaire. Interviewers were not told that mamey was the suspected vehicle. The 47-item questionnaire asked about their usual source of drinking water and about consumption of fresh vegetables and fruits, fruit juices, milk products, and different kinds of homemade and restaurant- or vendor-purchased batidos (banana, mango, mamey, passion fruit, and other). Each case subject and matched control subject was asked about exposures during the 30 days before onset of illness.

Interviewers were instructed to begin each conversation with a potential control subject in the language used to interview the case subject. Control subjects were obtained by systematic digit dialing, in which the interviewer called numbers constructed by sequentially adding and subtracting 1 digit to the last numeral of each case subject's telephone number until 4 control subjects were found.

Statistical Analysis

Data were entered and analyzed using the Epi-Info program (version 6.02; CDC). Mantel Haenszel matched odds ratios (MORs) and 95% confidence intervals (CIs) were calculated to assess associations between exposures and illness. Analyses were done with the probable case included and excluded; because the results were similar, we report only the results for all case subjects.

Tracebacks

Representatives of state and federal agencies visited case subjects’ homes and local restaurants and supermarkets to obtain samples of implicated products for testing. Implicated products were traced back to their manufacturers and countries of origin. Investigators from the US FDA and the country of origin inspected plants that manufactured the implicated products.

Results

Epidemiologic investigation. Hospitals reported 17 probable Salmonella Typhi cases during the outbreak period, and hospital laboratories forwarded isolates from 16 of them to the state central laboratory. The central laboratory confirmed 15
isolates as *Salmonella* Typhi. One isolate, from a 67-year-old Hispanic female, was identified as a non-Typhi *Salmonella*.

PFGE analysis showed that the genomic profiles of isolates from the 15 confirmed cases were indistinguishable and were different from those of *Salmonella* Typhi isolates identified in Florida during 1998 and 1999 that were not epidemiologically linked to the outbreak (figure 1). The isolate of the probable case not forwarded to the central laboratory was from an 8-year-old male who was diagnosed by a local hospital laboratory by use of an automated biochemical test (Microscan; Dade Behring), followed by identification of the O (somatic) and Vi (capsular) antigens.

The 1 probable and 15 confirmed outbreak-related case subjects were from 3 counties in south and central Florida: 13 from Miami-Dade, 2 from Palm Beach, and 1 from Pinellas. Their symptom onset dates ranged from 12 December 1998 through 11 February 1999 (figure 2). The 9 male and 7 female case subjects ranged in age from 3 to 65 years (median age, 21 years); all but 2 were Hispanic. One subject reported foreign travel (to Cuba) in the 30 days before illness onset. Reported symptoms included fever (100%), abdominal cramps (43.8%), diarrhea (37.5%), headache (31.3%), vomiting (31.3%), constipation (25%), and rash (25%). Fourteen case subjects were hospitalized. All 16 persons recovered, and none became carriers.

The epidemiologic investigation found that none of the case subjects was acquainted. They received their drinking water from at least 4 different municipal water systems. They shared no common recreational or social activities, and only 2 had been to the same restaurant in the 30 days before their illness onsets. None had been to the same grocery store or other food vendor. All stool cultures obtained from 42 household contacts were negative.

The matched case-control study conducted 16–18 February included the 1 probable and 11 confirmed case subjects who had been diagnosed and reported by 18 February. Interviewers located 4 control subjects for 11 case subjects and 1 control subject for 1 case subject. Two case subjects and 6 control subjects were eliminated from the final analysis because of incomplete or uncertain information about mamey consumption. The analysis described here included 1 probable and 9 confirmed case subjects and 39 matched control subjects.

In all analyses, consumption of *batidos* was the only exposure associated with illness, and mamey *batidos* were the only type of shake consumed significantly more often by case subjects (MOR, 7.6; 95% CI, 1.4–81.4; table 1). The strongest association was with mamey *batidos* purchased from a restaurant or vendor (MOR, 17.0; 95% CI, 1.4–650.1). Consumption of homemade *batidos* alone was not significantly associated with illness, either overall or by type of shake. Seven (70.0%) of the 10 case subjects recalled drinking a mamey *batido* in the 30 days before onset of illness, compared with 8 (20.5%) of the matched control subjects.

Food testing and tracebacks. All the mamey shakes were made with commercially packaged frozen fruit. State and federal inspectors visited 5 case subjects’ homes and 7 restaurants and 6 supermarkets that the case subjects frequented; they obtained 2 opened bags of the commercial product from case subjects’ homes, unopened samples from 6 of the restaurants and 1 supermarket, and 1 mamey shake produced at a restaurant. The samples included 3 brands; the 3 brands were marked as products

![Figure 1](https://example.com/figure1.png)

**Figure 1.** Pulsed-field gel electrophoresis analysis of DNA profiles of Florida *Salmonella* serovar Typhi isolates, comparing outbreak-related cases with others identified in 1998 and 1999.
of Guatemala or Honduras and were packaged in clear, 14-ounce plastic bags and, in some of the restaurants, in 5-pound bags. Subsequently, the DACS obtained additional samples for testing from 49 supermarkets and 12 distributors statewide. None of the laboratories that tested samples of the 3 brands of frozen mamey detected *Salmonella* Typhi in any sample. All the laboratories enumerated coliforms, including fecal coliforms and *E. coli*, in samples from all 3 brands. The DOH tested 102 samples of frozen mamey from unopened packages and enumerated fecal coliforms in 75.5% and *E. coli* in 71.6% (range, 10 to >1000 cfu/g). The FDA laboratory enumerated total coliforms (range, 23–240,000 cfu/g [most probable number]) and fecal coliforms and *E. coli* (range, 9.1–9300 cfu/g) in all 49 samples tested. The DOH found fecal coliforms in all 19 samples from case subject’s homes and commercial establishments (range, 23 to >1100 cfu/g). The DACS also tested 6 samples of frozen mamey produced in the Dominican Republic; all were negative for fecal coliforms. Although they are not pathogenic, fecal coliforms are signs of gross contamination and mishandling; their presence is considered a strong indication of poor hygiene and food handling practices [19].

On 18 February 1999, the DACS issued a stop sale order that halted the distribution and sale of all frozen mamey in Florida. On 20 February, the FDA issued a talk paper urging consumers to avoid eating 1 of the brands of frozen mamey, the only brand found in the case subjects’ homes. On 8 March 1999, the FDA announced a voluntary nationwide recall of 2 of the 3 brands of frozen mamey that had been found in case subjects’ homes or in supermarkets and restaurants the case subjects frequented. The 2 brands were distributed in 14 states, including Florida. The third brand was not being distributed at the time of the recall. No other state reported typhoid cases linked to consumption of frozen mamey. Genomic profiles of *Salmonella* Typhi isolates outside Florida did not match those that were posted on PulseNet. No locally-acquired cases of typhoid fever were reported in Florida after the recall.

The traceback investigation found that all brands of frozen mamey were produced in 2 plants in Guatemala and 1 plant in Honduras. Because no lot numbers were printed on the packages of frozen mamey, investigators could not trace the packages to specific plants. Inspectors from the Guatemalan government and the US FDA inspected the plants in Guatemala; the plant in Honduras was not inspected. Processing methods in Guatemala were similar in both plants: the fruits were washed, cut by hand, and the pulp was scooped out with spoons. At both plants, the fruit was then placed in a pulper, packaged, and frozen. Plant A used water from a shallow, hand-dug well to wash the fruit. Plant B washed its fruit with water from a deep well that served the local community; the water was chlorinated after it entered the plant. At Plant A, Guatemalan government inspectors noted structural problems, no record keeping, and an absence...
of good manufacturing practices. The plant owner chose to close rather than implement suggested structural changes.

Plant B had been built as a processing plant and had better food handling practices. Inspectors recommended improvements in record keeping and sanitation and provided training in sanitation practices. The government also recommended pasteurization, which is reportedly now being done (personal communication, Luis Flores, Agricultural and Environmental Integral Protection Program, Guatemalan Ministry of Agriculture/Association of Exporters of Non-Traditional Products, June 2001).

Discussion

This is the first report of a typhoid fever outbreak in the United States caused by a commercially imported food. Previous outbreaks have been linked to infected food handlers and contaminated water [20–26]. In the earlier outbreaks, the source of the infection was in the same community as the outbreak, which was the usual pattern for foodborne outbreaks in previous decades. This outbreak is an example of a new pattern of foodborne outbreaks, characterized by cases scattered across many counties, states, and nations [27]. This new pattern is an unintended consequence of centralized mass food production that permits wide distribution of a product contaminated early in the processing chain. In this case, the implicated product was distributed throughout the United States, representing potential exposure to thousands of people. The reason case subjects were identified only in Florida may relate to distribution patterns of the product: the contaminated batches may have been distributed and consumed only in Florida and/or only a small amount of product may have been contaminated.

Although this is the first typhoid fever outbreak in the United States linked to an imported processed food, imports have caused outbreaks of other exotic diseases, including cyclosporiasis and cholera [1, 3]. Future outbreaks are likely as expanded trade brings in food from all parts of the world. Although foodborne outbreaks from foods produced in the United States do occur, inspections by the FDA and the US Department of Agriculture provide some measure of safety. However, federal agencies have limited authority and resources to inspect products from other countries [3]. Moreover, the processing of foods may provide a false sense of security, as the processing (freezing and canning) implies that harmful organisms have been destroyed. Yet, Salmonella Typhi and other bacterial pathogens can survive freezing [3, 28].

These incidents highlight the need for new approaches to ensuring the safety of imported foods. Such approaches could include irradiating selected imported foods and working with producer countries to introduce Hazard Analysis and Critical Control Point (HACCP) systems. HACCP systems combine control of hazardous food processes with continuous monitoring to identify and correct dangerous conditions; they have been incorporated into the FDA’s Food Code and widely adopted by the US food industry [29].

Improved food safety also requires more sensitive laboratory techniques to identify exotic organisms in food. A major limitation of this investigation was the inability to detect Salmonella Typhi in the frozen mamey. This may have been because the contaminated mamey had already been consumed, although some of the mamey samples tested were highly contaminated with fecal organisms. However, current techniques may not be able to reliably detect Salmonella Typhi in food. In an experiment at the FDA’s Center for Food Safety and Applied Nutrition, separate flasks of lactose broth with and without mamey were seeded with Salmonella Typhi at levels up to 10^7 organisms/flask. No bacteria could be recovered from the flasks containing mamey, although Salmonella Typhi were recovered from the lactose broth flasks at concentrations as low as 10^6 organisms/flask.
flask (personal communication, Wallace Andrews, Center for Food Safety and Applied Nutrition, Washington, DC, April 1999). Similar problems have affected investigations of other foodborne outbreaks. An inability to identify the Cyclospora parasite in food hampered the investigation of the 1996 nationwide outbreak of cyclosporiasis, which eventually was traced to imported raspberries [1]. Recall bias was also a potential problem in this study; case subjects were repeatedly interviewed and had ample opportunity to remember mamey consumption, whereas control subjects were interviewed only once.

This outbreak demonstrates the importance of classic surveillance and epidemiologic techniques combined with modern molecular epidemiology in identifying outbreaks and their causes. Initially, no single hospital or clinician reported >1 case of typhoid fever. Identification of the outbreak depended on epidemiologists in the Miami–Dade County Health Department, who noted an unusual increase in locally-acquired typhoid fever cases, compared with historical data. PFGE analysis identified cases in other counties that were linked to the outbreak and excluded unrelated case subjects; this added power to the case-control study and prevented dilution of an outbreak and excluded unrelated case subjects; this added power to the case-control study and prevented dilution of an association by unrelated cases. Finally, although improvements in food testing and processing would make imported foods safer for Americans, the solution that would provide the greatest public health benefit is the provision of clean water and adequate sewage treatment systems worldwide.

Acknowledgments

We thank Luis Solorzano (consumer safety officer, US Food and Drug Administration), for providing assistance and information; Eric Mintz (Foodborne and Diarrheal Diseases Branch, Centers for Disease Control and Prevention), for coordinating the search for case subjects; and the Miami–Dade County Association of Professionals in Infection Control, for assistance with heightened surveillance for typhoid cases; and the Miami–Dade County, Palm Beach County, and Pinellas County health departments, for assistance with the outbreak investigation.

References