Journal of Food Protection, Vol. 67, No. 1, 2004, Pages 178–180

Research Note

Salmonella in Sesame Seed Products

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MS 03-143: Received 1 April 2003/Accepted 25 July 2003

ABSTRACT

In the context of an international outbreak of multiresistant *Salmonella* Typhimurium DT 104 that was correlated to the consumption of halvah (''helva,'' an Asian candy made from sesame seed), we examined several sesame seed products for the occurrence of *Salmonella*. Of 117 ready-to-eat food items containing sesame, we isolated salmonellae from 11 (9.4%) samples. In addition to finding *Salmonella* Typhimurium DT 104 in the halvah involved in the outbreak, we also isolated different *Salmonella* Typhimurium strains out of halvah from other manufacturers and countries of origin, as well as *Salmonella* Offa, *Salmonella* Tennessee, and *Salmonella* Poona from sesame paste (tahini) and sesame seed, which is sold for raw consumption in cereals.

Salmonella still plays a major role in bacterial foodborne diseases. Most of the salmonellosis cases (>90%) occur individually rather than as outbreaks. In Germany, the notified incidence of reported cases was 94:100,000 infections in 2001 *(4)*. Recent outbreaks of salmonellosis after consumption of products from plant origin (i.e., sprouts, chocolate, salad) have highlighted the relevance of sources of infections other than animal origin (i.e., egg, poultry, meat). In the spring of 2001, reports of recalls of a sesame seed product (halvah [''helva''], a candy made of sesame seed, sugar, and flavor) in Australia and Sweden because of contamination with multiresistant *Salmonella* Typhimurium DT 104 were submitted through the World Wide Web (ENTER-NET, Global-Salmsurv [GSS] and ProMED-mail). Investigators in Australia, Sweden, Norway, and Germany confirmed the outbreak and correlated the infections to the consumption of a suspected brand of halvah that was imported from Turkey *(1, 2, 5, 7, 10)*. An international alert notification was distributed through the European Commission's Rapid Alert System for Food. We studied infected patients and epidemiologically correlated the infections to the consumption of halvah. We also sampled various foods items made from sesame seeds from retail and delicatessen stores and examined them microbiologically for the occurrence of *Salmonella*.

Sesame seed in agriculture: harvest and processing. Sesame is the common name for the genus *Sesamum* of the family *Pedaliaceae* and is applied specially to the species *Sesamum indicum*. It is a broadleaf plant that grows about 5 to 6 feet tall. The seeds are unusually high in oil, around 50% of the seed's weight. Sesame is a high-value food crop, harvested both for whole seeds used in baking and for the cooking oil extracted from the seeds. Minor uses of sesame oil include pharmaceutical and skin care products. Its high oil and protein content (up to 25% protein by weight) makes it of high nutritious value, especially for the Middle East and large parts of developing countries. Sesame grows in all warmer zones near the equator. The total world production of sesame in 2001 was 3.15 million metric tons (mt), produced in 65 countries on a total agricultural area of 7.78 million hectares. About 60% is produced in Asia. The three main producer countries in 2001 were India (730,000 mt), China (790,800 mt), and Myanmar (426,384 mt) *(3)*. The United States is the largest importer of sesame, importing about 50,000 mt/year. The primary market for sesame in the United States is for the whole seed, used in a variety of baked goods (i.e., hamburger buns) and confections.

Although a major world oilseed crop, sesame is primarily grown by small farmers in developing countries. After the plants are cut and dried, the seed capsules split open and the seeds are easily extracted by shaking the plants upside down. During processing, the natural seed undergoes an initial screening and cleaning; the subsequent hulling can be done with the use of water (aqua-hulled) or mechanically. Aqua-hulled sesame will remain white after baking. The aqua-hulled sesame seed is very popular in hamburger bun production. Mechanically hulled sesame seed is produced by a low-temperature physical hulling and often enriches bakery and confectionary products. It is also the basis for tahini (sesame paste).

Production of tahini and halvah. Tahini is sesame paste produced from sesame seeds that are sieved and wet-cleaned in vats for the dehulling process. Cleaned and dehulled seeds are heated to 120°C and milled. The temperature of the product after milling is about 130°C, and the product, at this stage, is called tahini. Halvah is made by manually mixing tahini and acidified heated glucose syrup.

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TABLE 1. *Detection of* Salmonella *in sesame seed products by culturing (*n = *117)*

Food	No. of samples	Producer	No. of *Salmonella* serovars isolated
Sesame paste	12	8	1
Halvah	71	16	8
Sesame seed	16	6	2
Pastry	5	5	—
Sesame oil	7	4	—
Cereal	6	2	—
Total	117	25	11 (9.4%)

The sugar concentration of the syrup is high—not lower than 80 Brix (the concentration of dissolved sucrose) at a temperature of 140°C *(6).* After adding flavor or other ingredients (i.e., pistachio) the hot mass is poured into jars.

MATERIALS AND METHODS

Detection of *Salmonella* in sesame seed products by standard culture method. Culturing was performed according to the standard operating protocol of the Baden-Wuerttemberg State Health Office. Twenty-five grams of each food sample was preenriched in 225 ml buffered peptone water at 37°C. After preenrichment for 16 to 18 h, 1 ml (rather than 0.1 ml) of preenrichment broth was inoculated into 9 ml Rappaport-Vassiliadis broth, and 10 ml of preenrichment broth was inoculated into 90 ml Selenit-cysteine broth. For selective enrichment, both broths were incubated up to 48 h at 42°C. Broths were plated out after 24 and 48 h. As the selective plating media, we used modified Leifson agar and Rambach agar; for biochemical identification, we used double sugar iron agar according to Kligler *(8).* Presumptive *Salmonella* samples were serotyped according to their O (somatic), Vi (capsular), and H (flagellar) antigens *(9).* Serological classification was done according to the Kaufmann-White scheme. All positive results were further confirmed by the API test system (BioMérieux, Nürtingen, Germany). Phage typing of *Salmonella* Typhimurium strains was done by the German National Reference Center (Robert Koch-Institute), Wernigerode Branch, Germany.

RESULTS

Detection and identification of *Salmonella* in naturally contaminated food samples. During July 2001, we microbiologically investigated 117 samples of various sesame seed products bought in local retail and delicatessen stores in southwest Germany. The results of our examination of naturally contaminated food samples from the market are shown in Tables 1 and 2. Samples (117) of various food types (halvah, sesame seed, sesame paste, pastry, sesame oil, and cereal) from 25 different producers were tested (Table 1). Of these 117 samples, 11 (9.4%) from four different manufacturers (A to D) were found positive by culturing, and four different serovars were identified. Besides various strains of multiresistant *Salmonella* Typhimurium DT 104, we also found *Salmonella* Typhimurium DT 134, Offa, Tennessee, and Poona (Table 2). Six of the isolated strains showed the typical multiresistance to ampicillin, chloramphenicol, streptomycin, sulfonamides, and tetracyclines (ACSSuT) in phage typing and antibiotic resistance profile testing.

DISCUSSION

Contamination of sesame seed products with *Salmonella.* Sesame seed can be contaminated with *Salmonella* during growth, further storage, or processing. Irrigation and fertilization with manure and sludge, plant irrigation with surface water from streams, and animal droppings are potential sources of contamination. However, in sesame seed products in which the seed undergoes further treatment or processing, questions about the source of *Salmonella* contamination arises. Cross-contamination during the manufacturing process (i.e., by infected workers) are often mentioned. Good manufacturing practice and the hazard analysis critical control point (HACCP) concept should minimize such routes of contamination. Cross-contamination can occur in isolated cases or in countries where minimal standard hygiene conditions are not always maintained during production, but it seems unlikely for several reasons that contamination of sesame seed products occurs regularly during processing. Because of high temperatures (>120°C) and the inclusion of sugar in the production process, halvah is at this stage not a risk product in terms of *Salmonella* growth: cross-contamination at this stage would kill salmonellae that are not stress adapted (i.e., during a

TABLE 2. Salmonella *serovars isolated from 117 sesame seed food samples*

Product	Country of origin	Manufacturer	*Salmonella* serovar isolated	Flavor
"Helva"[a]	Turkey	A	Typhimurium DT 104	Vanilla
	Turkey	A	Typhimurium DT 104	Vanilla
	Turkey	A	Typhimurium DT 104	Pistachio
	Turkey	A	Typhimurium DT 104	Cocoa
	Turkey	A	Typhimurium DT 104	Pistachio
	Turkey	A	Monophasic B-strain	Vanilla
	Turkey	B	Poona	Cocoa
"Halawa"	Lebanon	C	Typhimurium DT 134	Pistachio
Tahini past	Turkey	A	Typhimurium DT 104	Native
Sesame seed	Germany[b]	C	Tennesee	Dehulled
Sesame seed	Germany[b]	D	Offa	Dehulled

[a] Halvah.

[b] Germany is distributor; country of origin not declared.

natural process of drying). Contamination as a result of improper hygienic conditions during packaging or transport would lead to the contamination of single jars, rather than of entire lots. Our finding that several products from different countries, as well as the raw sesame seed itself, were found to be contaminated with various *Salmonella* serovars makes it more likely that contamination happened during one of the harvest periods. During the same outbreak investigation, *Salmonella* Oranienburg and *Salmonella* Amsterdam were isolated in Australia *(1)* from sesame seed products (halvah) produced in Lebanon. Furthermore, the National Enteric Pathogen Surveillance Scheme in Australia has recorded the isolation of 17 different *Salmonella* spp. from sesame seeds and sesame seed products, including hummus, tahini, and halvah between 1985 and 2001 *(11)*. *Salmonella* contamination of sesame seed seems, therefore, to be a more urgent problem than previously thought.

Food microbiologists, public health professionals investigating incidents of foodborne illness, and people involved in the production chain have to be made aware that sesame seed and sesame seed products potentially could be contaminated with *Salmonella*. There is a further need to collect data on the microbiological quality of sesame and even on those products produced under circumstances that usually do not allow the survival of *Salmonella*. The importance of *Salmonella* vehicles other than raw or undercooked egg, poultry, meat, and eggshell must be recognized. The incidence of human salmonellosis associated with the consumption of plant products highlights the importance of hygiene and good manufacturing practices, especially during the various harvest processes.

ACKNOWLEDGMENTS

We thank our colleague Gerda Klittich for laboratory support and technicians Margit Ergenzinger and Ladia Zagorny for their assistance.

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