

The Occurrence of *Salmonella* in Airline Meals

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Hatakka, M. and K. Asplund: The occurrence of *Salmonella* in airline meals. Acta vet. scand. 1993, 34, 391-396. – The occurrence of *Salmonella* in airline meals was studied in 1989-1992. Samples were collected from flight kitchens in 29 countries. The material consisted of 400 cold dishes and 1,288 hot dishes as well as salads, cheese plates and deserts. Total number of samples was 2211. *Salmonella* spp. were isolated from 6 samples; 1 contaminated sample was a cold dish prepared in Bangkok, 1 was a hot dish prepared in Mombasa and the remaining 4 contaminated samples were hot dishes prepared within one week in Beijing. The isolated serotypes were *S. ohio*, *S. manchester* and *S. braenderup*. The contaminated cold dish prepared by a flight kitchen in Bangkok was found to be connected with a *Salmonella* outbreak which occurred in Finland in 1990. Cold airline dishes containing food of animal origin seems to be more risky as a source of *Salmonella* infections among airline passengers.

flight kitchen; travel catering.

Introduction

According to *Tauxe et al.* (1987) at least 23 outbreaks of foodborne illness involving 120 commercial airline flights were reported between 1947 and 1984 in the world. *Salmonella* was the most common pathogen in those incidents, causing 7 outbreaks; it was followed by *Staphylococcus*, causing 5 outbreaks, and *Vibrio* species, also causing 5 outbreaks. Salmonellosis is the main foodborne disease in many countries (*Bryan* 1981, *Todd* 1983, *Perez et al.* 1986, *Pöhn & Grossman* 1986). A *Salmonella* outbreak always causes considerable financial losses. In 1989, *Todd* reported preliminary estimates of the cost of foodborne diseases in the United States. He found that, from an economical point of view, salmonellosis was the most important foodborne disease, entailing to a total annual cost of \$4 billion.

Munce (1986) studied approx. 6,000 food samples collected from flight kitchens in 40

worldwide locations. *Salmonella* was isolated from approx. 1% of the samples. The most frequent isolations were made from airline food prepared in India and Indonesia. In a survey of 567 airline meals at Heathrow Airport, carried out in 1984-86, 0.5% of meals were found to contain *Salmonella* (*Roberts & Gilbert* 1986). A Finnish study of airline meals (991 samples) prepared in 23 different countries, carried out in 1986-90, revealed 0.2% *Salmonella* positive meals (*Hatakka & Korkeala* 1990).

According to *Tauxe et al.* (1987) the largest reported *Salmonella* outbreak associated with airline meals infected 550 out of 2,500 passengers (22%) in 1976. Six passengers died in the course of this outbreak. The survey revealed that the infection was caused by *S. typhimurium*, and that the vehicle of the infection was an egg salad, prepared in a Spanish flight kitchen.

Table 1. The number of airline meal samples examined for *Salmonella*, by the country where the meals were prepared, 1989-1992. (The number of *Salmonella* positive samples).

Country	Hot dish	Cold dish	Cheese plate	Salad	Dessert	Total
<i>Africa</i>						
Egypt	13	9	0	0	5	27
Kenya	10 (1)	6	0	1	5	22
<i>America</i>						
Barbados	5	3	0	3	3	14
Canada	3	4	0	0	3	10
Dominican Republic	4	3	0	2	2	11
Mexico	3	2	0	2	2	9
United States	8	2	0	0	0	10
<i>Asia</i>						
China	60 (4)	39	0	15	22	136
Japan	8	4	0	4	4	20
Malaysia	11	9	0	9	9	38
Thailand	22	12 (1)	0	5	8	47
<i>Europe</i>						
Austria	2	0	0	1	1	4
Belgium	7	2	3	2	2	16
Cyprus	2	0	0	2	2	6
Denmark	0	6	0	0	0	6
Germany	25	12	3	9	22	71
Finland	994	227	6	178	72	1,477
France	4	2	0	1	2	9
Greece	16	3	0	11	9	39
Hungary	2	2	0	0	0	4
Italy	14	4	0	10	9	37
The Netherlands	5	0	0	0	0	5
Norway	0	2	0	0	0	2
Portugal	8	7	0	0	3	18
Spain	37	19	1	11	18	86
Sweden	1	9	0	1	1	12
Switzerland	6	0	2	1	8	17
Turkey	13	3	3	9	9	37
United Kingdom	5	9	1	1	5	21
Total	1,288 (5)	400 (1)	19	278	226	2,211

Tauxe et al. (1987) reported that, in 1984, *S. enteritidis* had infected several passengers on 29 flights from London to the United States, the vehicle then being contaminated airline meals. A widespread outbreak of *S. infantis*, traced to food prepared in a Finnish flight kitchen, occurred in Finland in 1986 (*Hatakka*

1992). The number of persons at risk was 1122 including 350 airline passengers. On the basis of microbiological investigations, a total of 226 (20%) persons became infected, from which 91 were airline passengers. Food prepared by the flight kitchen in Palma de Mallorca was shown to have been the source of an

S. enteritidis outbreak infecting 71 passengers in 1989 (Jahkola 1989).

The meals served on aircraft entail the risk that airline passengers may become infected by *Salmonella*. The strict hygiene requirements set for flight kitchens constitute a basis for safe airline meals. The purpose of this study was to examine the occurrence of *Salmonella* in different meals prepared in flight kitchens located in various countries.

Materials and methods

Samples

The material was collected in 1989-1992. Altogether 2,211 airline meals were examined. The material consisted of 400 cold dishes, 1,288 hot dishes, 278 salads, 19 cheese plates and 226 desserts. Out of the 2,211 samples, 1,477 were gathered from 2 Finnish flight kitchens, the remaining 734 being sampled worldwide from flight kitchens located in 28 countries. The number of samples by the country and meals are shown in Table 1. The analysis was carried out from routine samples taken according to the control programme of the Finnish airline company, Finnair. The samples were stored in isolated boxes with dry ice during the flight to Finland and were kept frozen until the examination began. The Finnish samples were not frozen. The samples were examined at Vantaa Food and Environmental Laboratory.

Isolation of *Salmonella*

The isolation procedure was based on the method of Nordic Committee on Food Analysis (Anon. 1991). The sample for *Salmonella* analysis contained all different meal ingredients, altogether 25 g. The sample was transferred to 225 ml of buffered peptone water (Difco, Detroit MI, USA) and incubated for

24 h at 37°C. After pre-enrichment, 10 ml of the culture was transferred to 90 ml of tetrathionate broth (LAB M, Bury, England) and 0.1 ml of the culture to 10 ml of Rappaport-Vassiliadis broth (Oxoid, CM 866, Hampshire, England). Tetrathionate broth was incubated for 24 h at 37°C and Rappaport-Vassiliadis broth for 24 h at 41.5°C. After incubation, each enrichment broth was streaked on culture media. Two different plating media were used; bromthymolblue-lactose-saccharose-agar (Orion Diagnostica, Espoo, Finland) and *Salmonella* agar according to Önöz (Merck 15034, Darmstadt, Germany) until September 1990, when bromthymolblue-lactose-saccharose-agar was changed to brilliant-green-phenolred-agar (Orion Diagnostica). Bromthymolblue-lactose-saccharose-agar and brilliant-green-agar were incubated for 24 h at 37°C and Önöz agar for 48 h at 37°C. Two to 6 suspected colonies from each plate were inoculated into triple-sugar-iron-agar (Difco) and on to urea-agar (Difco). The serotyping of the *Salmonella* isolates was carried out by the National Salmonella Centre, National Public Health Institute, Finland, using the method of Kauffman (1966).

Results

Six (0.3%) out of the total of 2,211 samples tested were found to be *Salmonella* positive. *Salmonella* was not detected in the 1,477 samples prepared in 2 Finnish flight kitchens. Out of the 734 samples prepared in other flight kitchens, located in 28 countries, 6 (0.8%) were positive. Isolations of salmonellae were made from meals prepared in 2 Asian countries, Thailand and China, and in 1 African country, Kenya (Table 1). Five of the total 1,288 hot dishes (0.4%) and 1 of the total 400 cold dishes (0.3%) examined were *Salmonella* positive.

Table 2. *Salmonella* serotypes isolated from airline meals in 1989-1992.

Meal	Flight kitchen	Serotype
Cold dish, ham	Bangkok	<i>S. ohio</i>
Hot dish, chicken	Beijing	<i>S. braenderup</i>
Hot dish, beef	Beijing	<i>S. braenderup</i>
Hot dish, fish	Beijing	<i>S. braenderup</i>
Hot dish, crepes	Beijing	<i>S. braenderup</i>
Hot dish, beef	Mombasa	<i>S. manchester</i>

The first positive sample, isolated from a cold dish prepared in a flight kitchen in Bangkok, was found in February 1990. It contained ham, Edam-type cheese, boiled egg and cooked and marinated vegetables. The serotype was *S. ohio* (Table 2). The second occurrence of *Salmonella* bacteria was in samples taken between 27 July and 3 August 1990 from Beijing in China. *Salmonella* was isolated from 4 different hot meals, the serotype being the same in all 4 samples, *S. braenderup* (Table 2). The first hot dish contained chicken, mashed potatoes and beans; the second beef, mashed potatoes and cooked vegetables; the third fish, rice and cooked vegetables and the fourth was snack crepes. In January 1991, *Salmonella* was isolated from a hot dish prepared in Mombasa, Kenya. The dish consisted of beef, potatoes and cooked vegetables. The serotype isolated was *S. manchester* (Table 2).

The positive isolations made using 2 enrichment broths and 2 plating media are shown in Table 3. From the 6 positive samples detected, 5 were found with Rappaport-Vassiliadis broth while 3 were found with tetrathionate broth. One sample was positive only after enrichment in tetrathionate broth. The reliability of the results was better by using 2 different enrichment broths. *Salmonella* agar according to Önöz produced more isolations than the other 2 plating media.

Salmonella bacteria were not found in any cheese plates, salads or desserts studied (Table 2).

Discussion

Salmonella was isolated from 0.3% of all airline meals sampled from 29 different countries and examined in 1989-1992. The frequency of *Salmonella* in this study was similar to that detected in a study done in Finland in 1986-1990 (Hatakka & Korkeala 1990), where 0.2% out of 991 samples prepared in 23 different countries were found to be positive for salmonellae. The occurrence of *Salmonella* in the present study was somewhat lower than that in surveys carried out by Munce (1986) and Roberts & Gilbert (1986), who detected *Salmonella* in 1% and 0.5% of airline meals, respectively. If we exclude the samples from Finnish flight kitchens, the 0.8% rate of *Salmonella* positive samples detected in this study falls between the values reported by Munce (1986) and by Roberts & Gilbert (1986).

The 6 *Salmonella* isolations made in this survey were from meals prepared in 3 different countries, 2 of them located in Asia and 1 in Africa (Table 1). The contaminated airline food detected by Munce (1986) had also been prepared in Asian and African countries. The kitchens were located in Fiji, Hongkong, India, Indonesia, The Philippines, Thailand and Zimbabwe. The survey carried out by Roberts & Gilbert (1986) reported an occurrence of 0.5% of *Salmonella* in airline meals prepared at 10 British catering facilities serving the majority of airlines at London (Heathrow) Airport. This study also indicates that airline meals prepared in Asian and African countries seem to have a higher risk of contamination than meals prepared in Europe and America.

One of the *Salmonella* positive findings in this study (*S. ohio*) was subsequently found to be connected with an outbreak in Finland. The contaminated cold dish was served on a flight from Bangkok to Helsinki on the 15 February 1990. During the following 4 week period, the National Salmonella Centre of Finland recorded that 14 people had been infected by *S. ohio* (Jahkola personal communication 1992). Five passengers' gastrointestinal illness caused by *S. ohio* may have been connected with the cold dish served during the flight mentioned above. Thai authorities informed Finnair of *S. ohio* infections in people in Thailand during February 1990. The aircraft used for the above mentioned flight did not have cold storage facilities. The contamination of the cold dishes together with their transport unchilled during a long-haul flight was considered to have caused this outbreak. In co-operation with the caterer in Thailand, the airline decided to alter the high-risk cold food containing protein by removing the ham from the portion.

Foodborne illness was not found to be associated with positive findings in hot meals prepared by Beijing flight kitchen personnel between the 27 July and 3 August 1990. The serotype isolated from the 4 Beijing meals was the same, *S. braenderup*. The fact that different hot meals prepared on different days were contaminated by the same serotype may indicate that there was a carrier among food handlers or that the surfaces and facilities of the kitchen were contaminated. The hot meal prepared by a flight kitchen in Mombasa was not linked with foodborne illness among airline passengers after a charter flight from Mombasa to Helsinki.

All samples from salads were negative for *Salmonella*. Many international flight kitchens disinfect salad ingredients, such as lettuce, tomato and cucumber before preparing fresh

Table 3. *Salmonella* isolations with different enrichment broths and plating media.

<i>Salmonella</i> serotype	Enrichment broth			
	TT		RV	
<i>S. ohio</i>	S-	O+	S+	Ö+
<i>S. braenderup</i>				
chicken	S-	O-	S+	O+
snack	S-	O-	S+	O+
beef	S-	O+	S+	O+
fish	S-	O-	S+	O+
<i>S. manchester</i>	B-	O+	B-	O-

TT = Tetrathionate broth

RV = Rappaport-Vassiliadis broth

S = Bromthymolblue-lactose-saccharose-agar

O = Salmonella agar according to Önoz

B = Brilliantgreen-phenolred-agar

+ detected, - not detected

salad for airlines. As *Asplund & Nurmi* (1991) have shown, tomatoes stored at room temperature may be a possible vehicle of *Salmonella* spp. Disinfection may be an effective procedure for preventing *Salmonella* infections originating in salads. Likewise, *Salmonella* bacteria were not found in dessert samples. The reason may be that menu selection takes care of avoiding high risk desserts. Most of the desserts involved in this material were fresh fruits.

The presence of *Salmonella* bacteria in airline meals always presents a health risk for passengers and crew. Strict hygiene requirements must be enforced during the preparation, transport and serving of food for aircraft. In this study, *Salmonella* bacteria were isolated from cold and hot meals. The *Salmonella* positive finding from the cold dish only was confirmed to be connected with a foodborne outbreak. The risk of being infected by cold, especially protein containing airline meals is often connected with warm climate, long-haul flights and a shortage of refrigeration facilities at airports and on aircraft. Im-

portant factors to prevent *Salmonella* infections via hot dishes are fast chilling after preparing, chilled transport and storage with sufficient heat treatment on aircraft before serving.

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Sammanfattning

Forekomst av *Salmonella* i flygplansmåltider.

Forekomsten av *Salmonella* i flygplansmåltider undersöktes 1989-1992. Provtogs från flygkok i 29 länder. Undersökningsmaterialet bestod av 400 portioner kallrätt och 1,288 portioner såväl varmrätt som sallader, ostbrickor och desserter. *Salmonella* påvisades i 6 prov; 1 kontaminerat prov härstammade från en kallrätt tillredd i Bangkok, 1 från en varmrätt tillredd i Mombasa och de resterande 4 proven härstammade från rätter tillredda i Peking. De isolerade serotyperna var *S. ohio*, *S. manchester* och *S. braenderup*. Den kontaminerade kallrätten från Bangkok kunde kopplas till en *Salmonella* epidemi i Finland 1991. Kallrätter av animaliskt ursprung är risklivsmedel som utgör en källa till *Salmonella* infektioner hos flygresenärer.

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