PARATYPHOID FEVER ASSOCIATED WITH CHINESE FROZEN WHOLE EGG OUTBREAKS IN TWO BAKERIES

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For many years there have been outbreaks of paratyphoid fever associated with the consumption of imitation cream cakes and other confectionery made in commercial bakeries. One suspected means of entry of the paratyphoid bacillus into these bakeries has been contaminated products in common use (Cockburn *et al.*, 1951; Thomson, 1953). In 1954 two of us investigated a series of outbreaks of paratyphoid fever associated with bakeries where one small batch of Chinese frozen whole egg, used in all the bakeries concerned, was thought to have been contaminated, but where only a small amount was available for examination (Newell, 1955; Smith and Hobbs, 1955; Newell *et al.*, 1955). Various salmonellae were found, but not *Salmonella paratyphi B*.

In the present report are recorded two outbreaks of paratyphoid fever in August, 1955, one in the Worthing area and the other in the Weymouth area; bakery products were suspected of being directly responsible for the infection, and a batch of Chinese frozen whole egg used in the two bakeries appeared, on epidemiological grounds, to be the source of contamination. The epidemiological observations were confirmed by the isolation of the same phage type of *Salm. paratyphi B* from unopened cans of the egg, from some of the bakery staff, and from the patients.

Worthing Outbreak

Fourteen patients with an illness of the enteric fever type were found to be excreting *Salm. paratyphi B* phage type 3a; two of them were also found to be excreting *Salmonella thompson*. These illnesses began between August 7 and 21. Two patients had first had a gastro-intestinal illness lasting for less than twelve hours, and five to seven days later developed paratyphoid fever.

Five of the patients were holiday visitors and seven were from neighbouring areas, but 13 of them had eaten cakes filled with imitation cream (chocolate éclairs, cream buns, cream sponge) made in one bakery in Worthing between July 23 and August 6. Information was unobtainable from one person. No other common factor was found.

Bacteriological and serological examinations of the staff of the bakery and of the retail shops in which the cakes were sold were negative except for one woman who sold cakes in a retail shop and who had a gastro-intestinal illness on July 31, twelve hours after eating imitation-cream cakes. On August 25 she showed serological evidence of recent infection with *Salm. paratyphi B* although no salmonellae were found in her faeces or urine. She worked only in the retail shop and never in the bakery.

Salm. paratyphi B was not found in any home contacts of the patients, but one home contact was found to be excreting *Salm. thompson*.

Eight of the 13 patients whose food history is known ate cakes from retail shops outside Worthing but supplied by the central bakery. In these shops the time interval between production and consumption was some hours longer than with cakes sold in Worthing itself.

Weymouth Outbreak

Fourteen visitors and residents in South Dorset had an enteric illness starting between August 18 and September 14, and were found to be excreting *Salm. paratyphi B* phage type 3a. The mother of two of the patients was found to be a symptomless excreter of the same phage type. Three persons were also excreting *Salm. thompson*. Two had a gastro-intestinal illness five to eleven days before the beginning of their enteric fever.

All those persons had eaten cakes from a baker in Weymouth seven to fourteen days before the onset of their enteric illness, and many of them regularly ate a wide variety of cakes from this source. Two main varieties of cake were made—sponge filled with "butter cream," and chocolate éclairs and cream buns filled with a proprietary imitation cream. While many of the patients had eaten cakes of both types, all of them had eaten cakes filled with the proprietary imitation cream.

Many of the patients had bought cakes from a van which called three times a week, and here, as in the Worthing outbreak, there was a longer interval between production and consumption than in purchases made from retail shops in the town.

Two members of the staff of the bakery were found to be excreting *Salm. paratyphi B* phage type 3a. One was a bookkeeper who ate cakes regularly and had an illness of the enteric fever type on August 28 and was found to be also excreting *Salm. thompson*. The other was an apprentice pastrycook who said that he had not been well since August 16; he had made no specific complaints, but had stopped work and visited his doctor on August 30. An assistant in the shop attached to this bakery was found to be a symptomless excreter of *Salm. thompson*.

Between August 18 and September 27 there were four other cases of enteric fever among residents or visitors to South Dorset. Two were found to be excreting *Salm. paratyphi B* phage type 3b, and two phage type Taunton. One of the patients excreting phage type 3b had eaten cakes from another bakery that had used Chinese frozen whole egg of the same consignment but was in no way connected with the original cases. There is insufficient evidence to associate these patients with those excreting *Salm. paratyphi B* phage type 3a.

Products Used in Weymouth and Worthing Bakeries

The sources of those products thought to be relevant and used in the two bakeries at the suspected dates of infection were compared. They included frozen and dried whole egg, albumen, albumen products including marshmallow powders, flour, proprietary imitation creams, chocolate, sugar, essences, fillings, fondant, coconut, and fats. Many of these products were sampled separately and cakes filled with imitation cream were sampled in the course of manufacture.

The only product found in common was Chinese frozen whole egg packed in 22-lb. (10-kg.) upright cans, in single cartons, which had been imported by the Ministry of Food in the s.s. *Glenroy* in 1954.

The Worthing bakery accepted deliveries of this egg from July 14 to July 28; the batch was all used by July 31, when it was replaced by Turkish whole egg. No unopened cans of this shipment remained in Worthing when investigations were taking place, but one opened can which had been rejected by a baker because of its smell was sampled and found to contain *Salm. paratyphi B* phage type Taunton.

The Weymouth bakery used Chinese frozen whole egg in 44-lb. (20-kg.) cans until August 7, and then 22-lb. (10-kg.) cans ex s.s. *Glenroy*. This was in use until September 27, when a "standstill" order was placed on the remainder of this consignment in Weymouth under Section 18 of the Food and Drugs Act, 1938. On October 24 these cans were seized and destroyed by a Magistrate's Order under Section 10 of the Food and Drugs Act.

Bacteriological Findings

Cakes in the course of manufacture and their constituents were examined by the Brighton and Dorchester Public Health Laboratories. *Salm. thompson* was found in an opened package of an albumen compound used for meringues in Weymouth; all other examinations were negative for salmonellae.

Between September 23 and October 6 samples from 152 22-lb. (10-kg.) cans of Chinese frozen whole egg ex s.s. *Glenroy* were obtained from the cold store which supplied the Weymouth bakery. The tops of the frozen cans were cleaned and burned with methylated spirit, and a 60-80-g. sample was bored out with a brace and sterile bit. These samples were examined by the Food Hygiene Laboratory at Colindale; the results from the Weymouth and Worthing samples are shown in Table I. The samples

TABLE I.—Results of Examination for *Salmonellae* of Samples from 152 22-lb. (10-kg.) Cans of Chinese Frozen Whole Egg ex s.s. "Glenroy"

Salmonella	No. of Cans Contaminated
<i>Salm. thompson</i>	20
" <i>abderdeen</i>	1
" <i>pullorum</i>	23
" <i>paratyphi B</i> phage type Taunton	2
" " " " " 3a	2
" " " " "	2

TABLE II.—Growth of *Bacterium coli* at 22° C. in Imitation Cream Alone and in Contact with Confectionery (Bun and Eclair)

Time	Surface Colony Count per Gramme		
	Control (Alone)	Test on Bun	Test on Eclair
0 hour	60,000	70,000	75,000
1 day	< 500	3 million	17,500
2 days	< 500	25 "	100 million
3 "	< 500	450 "	Not done

were kept frozen until they were examined. Twenty-five-gramme quantities of egg were mixed with an equal amount of quarter-strength Ringer's solution and incubated at 37° C. for one to two hours, after which the appropriate amounts of double-strength selenite and tetrathionate liquid media were added; subcultures were made on deoxycholate citrate and Wilson and Blair agars after one day, and again after three days, for the selenite cultures (Smith and Hobbs, 1955).

Some cans contained more than one type of salmonella, and the two cans containing *Salm. paratyphi B* phage type 3a also contained *Salm. thompson* and *Salm. pullorum*.

Attempts were made to estimate the number of salmonellae present in samples from four cans containing *Salm. paratyphi B* and *Salm. pullorum*, two of which also contained *Salm. thompson*, by means of a technique similar to that used for the presumptive coliform count in water examination (Ministry of Health, 1939). The selenite fluid medium was used in place of MacConkey broth. The presumptive counts for *Salm. paratyphi B* varied from 10 to 1,800+ per 100 ml. The estimations were repeated and the counts of paratyphoid bacilli from one particular can were 250 and 1,800+ per 100 ml. on different occasions. From these results and from those given in Table I, it is clear that the organisms were distributed very irregularly, not only in different cans but in different parts of the same can.

Salm. thompson counts varied from 17 to 45 per 100 ml. The counts of *Salm. pullorum* were 1,800+ per 100 ml. in three cans and 600 per 100 ml. in one can.

Phage-typing of the paratyphoid B bacillus was introduced by Felix and Callow (1943) (see also Felix and Callow, 1951). The phage type of a strain of *Salm. paratyphi B* is for all practical purposes a stable characteristic, and its identification provides a "finger-print" whereby groups of cases of paratyphoid fever may be defined and linked up with their source of infection. It has been used in this way in these two outbreaks and also for tracing an organism from a contaminated vehicle through the bakery to the patients. The phage-typing in this investigation was carried out by the Central Enteric Reference Laboratory and Bureau, Colindale. Because no similar procedure was available for *Salm. thompson*, it was not possible to discover whether the bakery staff and the patients excreting this organism were infected through frozen whole egg or through albumen.

Discussion

Two outbreaks of paratyphoid fever associated with imitation-cream cakes made in commercial bakeries have been investigated. The connexion with the bakery was strengthened in the Weymouth outbreak by the finding of the same phage type of paratyphoid B bacillus in two members of the staff. The vague illness of the apprentice pastrycook occurred seven days after the first use of a contaminated batch of Chinese frozen whole egg, and four days before the onset of illness of the first patient. Even if this boy was indirectly responsible for some of the early cases, the fact that the onset of illness of the last Weymouth patient was 27 days after the boy had stopped working shows that he is unlikely to have been responsible for all of them.

Three questions require consideration.

(a) Why is it, if the Chinese egg was the original source of infection, that the cases were caused only by *Salm. paratyphi B* phage type 3a? It is impossible to answer this question satisfactorily. Examination, however, of Table I, taken in conjunction with the results of examining large numbers of other batches of Chinese frozen whole egg, leaves no doubt that this product is extensively contaminated with different members of the *Salmonella* group, including *Salm. paratyphi B*. The product in any one can is not homogeneous, and the organisms are therefore not distributed uniformly throughout the mass. It follows that which particular organism gains access to a given batch of cakes filled with imitation cream must be largely a matter of chance. Though these particular outbreaks were caused by *Salm. paratyphi B* phage type 3a, it may be noted that in Weymouth there were other cases, having a possible association with the bakery, which were infected with phage type Taunton—one of the three phage types of paratyphoid bacilli found in the frozen whole egg.

The evidence incriminating the egg is strengthened by the findings that in the Worthing outbreak two patients and one healthy person were excreting *Salm. thompson*, and in the Weymouth outbreak three of the patients and two members of the bakery staff were excreting this organism. Apart from *Salm. pullorum*, which is usually non-pathogenic to man, *Salm. thompson* is found more often than any other type of salmonella in Chinese frozen egg. This organism is the third commonest type of salmonella in food-poisoning in this country, and is seldom found in any other article of food than egg. The occurrence of eight cases of *Salm. thompson* infection in the Worthing and Weymouth outbreaks associated with a batch of frozen egg that contained large numbers of this particular type of organism cannot but be regarded as aetiologically significant.

(b) If Chinese frozen egg was the original source of infection, how did it lead to contamination of the imitation-cream cakes? Interrogation of the master pastrycooks in the two bakeries concerned revealed that the cans of egg had been stored in the same refrigerator as the cans of imitation cream, and that the same dispensing measures

had been used for both products. Though egg was not represented in the formula of the imitation cream, it nevertheless often gained access to the cream fortuitously.

(c) If paratyphoid bacilli gained access to the imitation cream, would the cream be thereby rendered infective for man? There is reason to believe that paratyphoid bacilli are able to give rise to disease in man only when ingested in considerable numbers. It may therefore be assumed that multiplication of the organism must occur in the cream before this becomes infective. Hobbs and Smith (1954) showed that synthetic cream could be divided into two groups—those that supported bacterial growth and those that did not. They further showed, in confirmation of Thomson's (1953) work, that cream belonging to the second group was converted into a rich nutrient medium by contact with flour, cakes, or other source of protein. This is illustrated by Table II, kindly provided by Miss J. Glanville, which shows that *Bact. coli*, though actually dying in imitation cream itself, multiplied abundantly when the cream was kept at room temperature in contact with buns or éclair casings.

The length of time required for sufficient growth of paratyphoid bacilli to occur to render the cakes infective must necessarily depend upon many factors, such as the number of paratyphoid bacilli introduced initially, the number of other organisms present, the nature of the cake or other mixture into which the cream is brought into contact, the degree of heating, if any, that the cake may receive, and the time and temperature of incubation in the shop, on the round, and in the customer's home. In this connexion it is interesting to notice that most of the patients in these two outbreaks had bought their cakes, not directly from the bakery where they were made, but from outlying shops supplied by the bakery or from a roundsman. Under these conditions there was almost certainly a delay in the consumption of the cakes, thus favouring the multiplication of the organism in the cream.

We have assumed here that the cream acted as the direct vehicle of infection. It must be realized, however, that, once contamination is introduced into a bakery, other articles must inevitably become contaminated. Many of these articles will be epidemiologically of no importance, because they will be subjected in baking to a sufficient degree of heat to kill off non-spore-forming pathogenic organisms such as those of the *Salmonella* group. It is because imitation cream is not subjected to any serious heat treatment after it has been added to articles of confectionery, and because, in conjunction with nutrient materials provided by the cake itself, it provides such an excellent pabulum for bacterial growth, that it must be regarded as of special potential danger.

To protect against outbreaks of this sort known contaminated products must be prevented from gaining access to a bakery. Hobbs and Smith (1954) suggested the use of hydrogen peroxide to prevent the growth of any pathogenic organisms that may gain access to synthetic cream adventitiously.

It need hardly be added that strict control should be kept over the health of employees in bakeries; but the experience of the Public Health Laboratory Service has shown that, though cases and symptomless excretors are not uncommon among bakery employees, they almost invariably give a history of having eaten the contaminated cream buns or cakes. There is growing evidence to support the view that bakery products usually become contaminated not primarily from infected members of the staff but from inanimate articles introduced from outside, of which Chinese processed egg in its various forms is the most common.

Summary

Two outbreaks of paratyphoid fever due to *Salm. paratyphi B* phage type 3a are described.

The vehicle of infection was cakes filled with a proprietary imitation cream used in two bakeries.

The same phage type of paratyphoid bacillus was found in unopened cans of Chinese frozen whole egg used in the bakeries, in some members of the staff, and in the patients.

It is suggested that the imitation cream was contaminated within the bakery by *Salm. paratyphi B* from the frozen whole egg.

The dangers of the use of a contaminated product in a bakery are discussed.

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JAMSHEDPUR FEVER*

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Jamshedpur fever is the name given to a peculiar illness which started in the city of that name and affected children and young adults, having the highest mortality among the very young. Later it spread to other cities such as Lucknow, Delhi, Kanpur, Allahabad, Calcutta, and Nagpur. Jamshedpur, unlike some of its neighbours, is a clean and well-planned city with a population of about 251,619 (1951 census); it has a very fine water supply and an excellent sewage system. The standard of health among the population, which consists largely of employees in the iron and steel industry and their families, is good.

The illness was first observed in Jamshedpur on May 14, 1954. A child about 1 year of age suddenly developed respiratory distress with a temperature of 103° F. (39.4° C.). Moist sounds were heard on both sides of the chest, and a provisional diagnosis of bronchopneumonia was made. The child died in two hours. About a fortnight later another child from the same

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