Mayonnaise, Sandwiches and *Salmonella*

B. SWAMINATHAN*, J. M. HOWE, and C. M. ESSLING

Department of Foods and Nutrition, Food Sciences Institute, Purdue University, West Lafayette, Indiana 47907

(Received for publication May 27, 1980)

**ABSTRACT**

Sandwiches, prepared with home-cooked or commercially purchased turkey meat and made with or without commercially available mayonnaise, were inoculated with approximately 600-700 cells of a nalidixic acid-resistant strain of *Salmonella typhimurium* per gram of each sandwich. The sandwiches were incubated at 4, 21, and 30°C and samples analyzed at 4, 8, and 24 h for the number of *S. typhimurium* cells. Significant increases in the number of *S. typhimurium* cells were found in sandwiches prepared without mayonnaise and containing home cooked turkey meat after 8 h of incubation at 30°C and 24 h of incubation at 21 or 30°C. The increase in numbers of *S. typhimurium* in sandwiches prepared with commercially processed turkey meat was significantly lower than the increase in sandwiches prepared with home-cooked turkey meat. Mayonnaise had a significant inhibitory effect on growth of *S. typhimurium* in sandwiches prepared with turkey breast meat; however, mayonnaise did not prevent *Salmonella* from multiplying when the sandwiches were stored at 21 or 30°C for 8 or 24 h.

The role of mayonnaise in foodborne infections and intoxications involving contaminated sandwiches and salad dressings has recently become a subject of debate. Mayonnaise is often listed as one of the major culprits in bacterial foodborne diseases (1, 2). In 1976, a food poisoning outbreak involving 500 airline passengers in Europe was traced to mayonnaise contaminated with *Salmonella typhimurium* (4). However, the high acid content of commercial mayonnaise in the U.S. suggests an improbability of growth of food poisoning organisms in salad dressings and sandwiches (6, 7, 13). A study conducted at the Food Research Institute of the University of Wisconsin (8) showed that mayonnaise inhibited growth of *Salmonella* and *Staphylococcus aureus* in salads containing diced chicken or diced ham and stored for 5 or 24 h at room temperature. A subsequent bulletin from the Science and Education Administration of the U.S. Dept. of Agriculture (10) pointed out that the Food Research Institute study did not resolve the questions as to whether commercial mayonnaise would keep a food safe and how much mayonnaise needed to be present to assure microbiological safety. The U.S.D.A. bulletin recommended that consumers should not rely on mayonnaise to ensure the safety of their food.

A few studies have been conducted on the incidence of *Salmonella* in commercially prepared sandwiches (3, 11, 12). These studies have shown that *Salmonella* is not a major problem in commercially prepared sandwiches. However, no reports have been published on survival of *salmonellae* in home-made sandwiches prepared with or without mayonnaise. This study was conducted to determine the influence of mayonnaise on the fate of *S. typhimurium* in sandwiches prepared in the same manner as they are normally prepared at home.

**MATERIALS AND METHODS**

**Design of experiment**

The factorial design (1-4) was comprised of two sources of turkey meat, home-cooked and commercially processed; with or without added mayonnaise. Following inoculation with *S. typhimurium* (600 to 700 cells per gram of sandwich), the sandwiches were incubated at three temperatures for three time periods as indicated in Fig. 1. The three temperatures were chosen to simulate common storage conditions for sandwiches, i.e. refrigerator (4°C), room temperature (21°C) and hot locker or a lunch box in the car (30°C).

The data obtained were analyzed statistically by analysis of variance using Statistical Library Program BMC 02V at the Purdue University Computer Science Center.

Figure 1. Experimental design for the determination of the growth of *Salmonella typhimurium* in turkey sandwiches (triplicate samples of sandwiches from each treatment were examined for the numbers of *S. typhimurium* cells at 4 h, 8 h, and 24 h of incubation).
Turkey meat for sandwiches

Frozen, whole turkey was purchased from a retail grocery store in West Lafayette, IN. The turkey was roasted at 163°C in an oven to an endpoint temperature of 85°C measured in the center of the inner thigh. A 28-g portion of the breast meat of the roasted turkey was used to prepare each sandwich containing home-cooked turkey meat. Freshly sliced, processed turkey breast obtained from a local delicatessen was used to prepare sandwiches containing commercially processed turkey meat. The label on the processed turkey breast indicated that turkey broth, salt and phosphate had been added to the commercial turkey product. Preparation of sandwiches

A thin, even coat of margarine (approximately 4 g) was applied to each slice of regular, white, enriched bread. Sandwiches were prepared by placing 28-g slices of home cooked or commercially processed turkey breast meat between slices of margarine-coated bread slices. To prepare sandwiches with mayonnaise, a 9-g portion of commercially purchased mayonnaise (Kraft Inc., Chicago, IL) was spread on one of the bread slices (I5).

Preparation of the inoculum

A nalidixic acid-resistant strain of S. typhimurium was obtained from Dr. E. V. Morse, Dept. of Veterinary Microbiology, Purdue University. The stock culture was maintained on nutrient agar (DIFCO) at room temperature. The culture was grown overnight in 5 ml of Tryptic Soy Broth (DIFCO) at 37°C. The cells were washed with Butterfield's Phosphate Buffer (PBS) three times and were suspended in 5 ml of PBS. The number of cells of S. typhimurium in suspension in PBS was determined by spreading appropriate dilutions of the suspension on tryptic soy agar containing 250 µg of nalidixic acid (Sigma Chemical Co., St. Louis, MO)/ml. The filling in each sandwich was inoculated by pipetting 0.1 ml of a 10^4 dilution of a suspension of S. typhimurium on each side of the turkey breast meat. The sandwiches were loosely wrapped in aluminum foil and were incubated at the appropriate storage temperatures.

Enumeration of S. typhimurium in sandwiches

Each sandwich was homogenized in an appropriate volume (10 ml/g of sandwich) of PBS in a Waring blender at low speed for 2 min. The homogenate was allowed to remain at room temperature for 10 min. Appropriate dilutions of the homogenate were plated in triplicate on tryptic soy agar containing 250 µg of nalidixic acid ml. The plates were incubated for 24 h at 37°C and colonies were counted. At least two representative colonies from each plate were screened biochemically (triple sugar iron agar, lysine iron agar and urea agar) and serologically by slide agglutination with Salmonella somatic group B antisera (DIFCO) to confirm the presence of Salmonella.

pH Determinations

The pH of four commercial brands of mayonnaise obtained from a local supermarket was determined using a Beckman Zeromatic pH meter. The pH of the turkey meat was determined with a combination electrode with a spear tip (Cole-Palmer Instrument Co., Chicago, IL) after the meat was ground through a 1/8" plate.

RESULTS AND DISCUSSION

The extent of multiplication of S. typhimurium in sandwiches prepared with home cooked turkey meat filling is shown in Table 1. After 4 h of incubation, there was a tremendous increase in the numbers of S. typhimurium in all sandwiches stored at 21 or 30°C. Again, the extent of multiplication of S. typhimurium in sandwiches containing mayonnaise was significantly less than that observed in sandwiches prepared without mayonnaise. Sandwiches stored at 4°C showed no increase in the numbers of S. typhimurium after 24 h of incubation.

Table 1. Growth ratios for S. typhimurium in sandwiches prepared with home-cooked turkey meat.

<table>
<thead>
<tr>
<th>Time Temp. of Samp. Incubation (C)</th>
<th>Sandwiches without mayonnaise</th>
<th>Sandwiches with mayonnaise</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Growth ratio (N_T/N_O)^2</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1.06 ± 0.12b</td>
<td>1.12 ± 0.08</td>
</tr>
<tr>
<td>4</td>
<td>1.10 ± 0.11</td>
<td>1.12 ± 0.14</td>
</tr>
<tr>
<td>4</td>
<td>3.62 ± 0.15</td>
<td>1.33 ± 0.01</td>
</tr>
<tr>
<td>4</td>
<td>1.07 ± 0.16</td>
<td>1.21 ± 0.10</td>
</tr>
<tr>
<td>8</td>
<td>1.53 ± 0.20</td>
<td>1.66 ± 0.37</td>
</tr>
<tr>
<td>8</td>
<td>97.14 ± 18.42</td>
<td>27.10 ± 6.96</td>
</tr>
<tr>
<td>4</td>
<td>1.06 ± 0.10</td>
<td>1.10 ± 0.10</td>
</tr>
<tr>
<td>24</td>
<td>1579.75 ± 80.06</td>
<td>25.56 ± 8.85</td>
</tr>
<tr>
<td>24</td>
<td>502709.61 ± 146777.78</td>
<td>23210.63 ± 1074.53</td>
</tr>
</tbody>
</table>

1Legend: N_T = number of cells of S. typhimurium per gram of sandwich at time (T).
N_O = number of cells of S. typhimurium initially inoculated per gram of sandwich.

The extent of multiplication of cells of S. typhimurium in sandwiches prepared with commercially processed turkey meat filling is shown in Table 2. No increase in the numbers of S. typhimurium was observed after 4 h of incubation in any of the sandwiches (with or without mayonnaise) stored at 4, 21, or 30°C. After 8 h of incubation, only the sandwiches prepared without mayonnaise and stored at 30°C showed a significant (p<0.01) increase in the numbers of S. typhimurium between sandwiches prepared with home-cooked turkey meat filling was noted in any of the sandwiches stored at 4°C. At 21 or 30°C, sandwiches prepared with mayonnaise showed less proliferation of S. typhimurium than sandwiches prepared without mayonnaise. In fact, the sandwiches prepared with mayonnaise and commercial turkey meat filling actually showed a decrease in the number of S. typhimurium after 24 h of incubation at 30°C.

The results indicated a highly significant difference (p<0.01) in the increase in numbers of S. typhimurium between sandwiches prepared with home-cooked turkey meat and sandwiches prepared with commercially purchased turkey meat. Also, a highly significant difference (p<0.01) was observed in the multiplication of S. typhimurium in sandwiches containing mayonnaise and in sandwiches prepared without mayonnaise.

The pH of the four commercially purchased mayonnaise samples ranged from 3.79 to 3.91. Smittle (13)
Staphylococcus aureus demonstrated the inhibitory effect of commercially used cooked turkey meat was 6.24 while that of the indicated that commercially processed mayonnaise in the to be approximately the University of Wisconsin (7) indicated that the previous reports on the inhibitory action of mayonnaise prepared with commercially processed turkey meat. 

The decreased rate of multiplication of Salmonella typhimurium in sandwiches prepared with commercial turkey meat and mayonnaise and stored at 30°C for 24 h may be the result of a synergistic action between mayonnaise and phosphates in commercially processed turkey meat. The inhibitory effect of the ingredients of commercially processed meat fillings on growth of Salmonella typhimurium may explain the failure of Khan and McCaskey (11) McCroan et al. (12) and Christiansen and King (3) to detect salmonellae in commercially prepared sandwiches containing poultry meat fillings. Further, several investigators have shown that salmonellae are destroyed within 1 day in mayonnaise or mayonnaise-like products stored at room temperature (13).

Results of this investigation indicate that home-cooked turkey meat supported growth of Salmonella typhimurium more readily than commercially purchased turkey meat. It was observed that mayonnaise had a significant inhibitory effect on growth of Salmonella typhimurium in sandwiches prepared with turkey breast meat. However, it has also been observed that mayonnaise will not offer adequate protection if the sandwiches are stored at room temperature (21°C) or in hot lockers (30°C) for unduly long periods (8 to 24 h). The results of this study indicate that sandwiches containing mayonnaise and sliced turkey breast meat fillings may be stored at room temperature (21°C) for periods not exceeding 4 h. However, the best protection afforded sandwiches prepared with turkey meat against growth of salmonellae would be to store the sandwiches in a refrigerator (4°C) until consumption.

**REFERENCES**

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*JOURNAL OF FOOD PROTECTION. VOL. 44, FEBRUARY 1981*
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