THERMAL RESISTANCE OF FOOD POISONING ORGANISMS IN POULTRY STUFFING

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(Received for Publication February 4, 1956)

Thermal death times of food poisoning types of organisms as represented by Salmonella enteritidis, Micrococcus pyogenes var. aureus, and Streptococcus faecalis in poultry stuffing were investigated. The thermal destruction characteristics of these organisms are described in terms of z and F100 values. Streptococcus faecalis was considerably more heat resistant than the other two organisms studied. The data obtained indicate that roasting procedures for stuffed poultry, based on the attainment of a center stuffing temperature of 165°F., should be adequate to destroy such organisms if present in the stuffing.

Roast poultry and poultry stuffing have been frequently implicated in food poisoning outbreaks. In view of the role of poultry in such food poisoning outbreaks, the present investigation was conducted to obtain data on the thermal death time characteristics of certain food poisoning bacteria in poultry stuffing.

Studies on roasting times and temperatures required to kill food poisoning organisms added to the stuffing of turkeys have been reported by Castellani et al. (2). They concluded that a temperature of 165°F. reached in the center of the stuffing during the roasting period appears sufficient to kill streptococci, staphyloccci, and salmonellae and to allow a modest margin of safety. It was also observed that an active bacterial multiplication occurs during the earlier phases of the roasting process. This period of microbial growth was longer in the larger birds where the rate of heat penetration into the stuffing is slower.

In the present investigation the thermal destruction characteristics of one strain each of staphyloccci, streptococci and salmonella were determined in poultry stuffing in thermal death time tubes at several temperatures in the range of 125° to 150°F.

Poultry Stuffing:

Samples of stuffing were removed from frozen stuffed turkeys packed by four different commercial plants engaged in the preparation of this product. The ingredients of these poultry stuffings included bread, water, celery, shortening, onions, and in some cases, seasonings and giblets. A typical analysis of such poultry stuffing as given by Esselen and Levine (3) is as follows:

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>44.9</td>
</tr>
<tr>
<td>Protein (N x 6.25)</td>
<td>7.6</td>
</tr>
<tr>
<td>Fat (ether extract)</td>
<td>18.4</td>
</tr>
<tr>
<td>Extract matter (carbohydrate)</td>
<td>26.2</td>
</tr>
<tr>
<td>Ash</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Preparation of Poultry Stuffing Substrate:

To facilitate handling during thermal death time tests the poultry stuffing was diluted with distilled water and sterilized. One part by weight of stuffing to four parts distilled water were mixed in a Waring Blender for five minutes. Fifty-ml. portions of the diluted stuffing in 125-ml. Erlenmeyer flasks plugged with cotton and containing 15 glass beads were sterilized in an autoclave for 15 minutes at 15 pounds steam pressure. The pH values of the poultry stuffing substrate ranged from 5.9 to 6.1.
Organisms:

A strain of *Salmonella enteritidis* (from the Department of Bacteriology, University of Massachusetts) and *Micrococcus pyogenes* var. *aureus* and *Streptococcus faecalis* 7080 (from American Type Culture Collection) were used as test organisms. The former was grown on nutrient agar (Difco) slants at 98.6°F., and the latter two organisms were cultured on tryptose agar (Difco) at 98.6°F. Inocula of these organisms were prepared from 24-hour agar slant cultures. Two ml. portions of the inoculated poultry stuffing substrate were filled into sterile thermal death time tubes (Pyrex glass tubes 7 mm. inside diameter and 150 mm. in length) by means of a sterile pipette. The tubes were then flame and sealed with sterile cotton plugs. They were kept in an ice water bath prior to being heated. The tubes were heated in an electrically heated constant temperature water bath controlled to within ± 0.5°F. by means of a thermostatic regulator. For heating, the tubes were placed in copper racks that accommodated six tubes each. A wire handle was attached to the rack allowing immersion to within one inch of the top of the tube. Two tubes of substrate were heated for each time and temperature interval per run. A minimum of five time intervals was used at each temperature, and a minimum of four temperatures (in the range of 125°F. to 150°F.) was used in the determination of thermal destruction rate characteristics. The heating times were corrected for a pre-
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FIGURE 1: Thermal death times curves of Micrococcus pyogenes var. aureus, Salmonella enteritidis, and Streptococcus faecalis in poultry stuffing.

previously determined heating lag correction factor of 1.4 minutes. The thermal death time tubes were immersed in the water bath for specified times after which they were removed and immediately placed in ice water to cool. The contents of the tubes were then diluted and plated out in appropriate media to determine the number of surviving organisms.

Subculturing Heated Poultry Stuffing:

One ml. portions of heated substrates were transferred to sterile dilution bottles containing distilled water. Decimal dilutions were made and plated in duplicate on the following media:

Salmonella enteritidis on trypticase soy agar

Micrococcus pyogenes var. aureus on tryptose phosphate agar (Difco)

Streptococcus faecalis on trypticase soy agar

The plates were incubated at 98.6°F for 48 hours and counted. The initial number of organisms in the inoculated stuffing prior to heating in the thermal death time tubes was determined by plating unheated controls.

Definition of Terms:

The observed thermal resistance characteristics of the organisms studied are described according to the concepts of Ball (1) and Stumbo (5), and are designated by the following terms:

\[ F_{140} \] = A symbol that represents the number of minutes required at 140°F, assuming instantaneous heating and cooling, to reduce the number of microorganisms of a given species, present in a given quantity of substrate, to a given level.

\[ z \] = The slope of the thermal death time curve expressed as the number of degrees Fahrenheit on the temperature scale traversed by the curve in passing through one logarithmic cycle on the time scale.

\[ D \] = The time in minutes at a given temperature required to reduce the original bacterial population by 90% assuming instantaneous heating and cooling.

RESULTS AND DISCUSSION

The results of the thermal destruction rate tests with Salmonella enteritidis, Micrococcus pyogenes var. aureus, and Streptococcus faecalis in poultry stuffing are summarized in Table 1. The data obtained are grouped together inasmuch as little or no difference in thermal destruction rates for the three test organisms in the four different kinds of commercial poultry stuffing studied was observed. These data were plotted on semilogarithmic paper to obtain thermal destruction rate curves and their corresponding \( D \) values (time for 90 per cent destruction)

TABLE 2 - THERMAL DEATH TIME CHARACTERISTICS OF
Salmonella enteritidis, Micrococcus pyogenes var. aureus, and Streptococcus faecalis in Poultry Stuffing.

<table>
<thead>
<tr>
<th>Organism</th>
<th>( z )</th>
<th>( F_{140} )</th>
<th>( F_{150} )</th>
<th>( F_{160} )</th>
<th>( F_{165} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella enteritidis</td>
<td>0.1</td>
<td>19.25</td>
<td>1.85</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>Micrococcus pyogenes var. aureus</td>
<td>12.3</td>
<td>15.4</td>
<td>2.45</td>
<td>0.38</td>
<td>0.15</td>
</tr>
<tr>
<td>Streptococcus faecalis</td>
<td>14.2</td>
<td>67.2</td>
<td>13.5</td>
<td>2.68</td>
<td>1.20</td>
</tr>
</tbody>
</table>

at the different temperatures used. The curves so obtained followed a straight line in most cases. In order to obtain thermal death time curves the \( D \) values for different temperatures were plotted against time on semilogarithmic paper. The slope or \( z \) value of the thermal death time curves could then be obtained. The thermal death time characteristics of the test organisms are expressed in terms of \( F_{140} \), \( F_{150} \), \( F_{160} \), \( F_{165} \) and \( z \) values as shown in Table 2. The \( F_{140} \) value refers to the destruction time at 140°F.

The \( F \) values were taken as the time required to
achieve 99.9999% destruction or seven times $D$ (time for 90% destruction at a given temperature). Corresponding $F_{96}$ values (time for 99.9999% destruction of organisms at 165°F) are also shown in Table 2 in view of the observations of Castellani et al. (2) that a temperature of 165°F reached in the center of the stuffing during the roasting period appears sufficient to kill streptococci, staphylococci, and salmonellae and to allow a modest margin of safety. Thermal death time curves for these three organisms in poultry stuffing are presented in Figure 1.

The thermal destruction rates of the three organisms studied indicated a logarithmic order of death. The only notable deviations from straight line destruction rate curves were found with *Streptococcus faecalis* at the lower temperatures. The $z$ values obtained were slightly higher than the value of 9 as given by Gross and Vinton (4) and others, for nonsporeforming bacteria. *Streptococcus faecalis* exhibited a considerably higher degree of heat resistance than the Micrococcus and Salmonella.

The recommendations of Castellani et al. (2) that a temperature of 165°F be reached in the center of the stuffing of poultry during the roasting period would appear to be adequate to destroy food poisoning organisms of the heat resistance observed in the present investigation even if they were present in large numbers.

**REFERENCES**