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HACCP AND SLOW-ROASTING TURKEYS

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Introduction

Slow roasting turkey overnight seems to be a very common practice dating from the 1930s. There has been a persistent question, however, about the microbiological safety of slow-roast poultry, especially in terms of the production of *Staphylococcus aureus* toxin. In 1988, a well-done study was run at the University of Minnesota, Department of Food Science, by Eckner, Zottola, and Gravani, which provided the answer to the question of safety.

The study

Four frozen turkeys were used in the study. The turkeys were thawed in a refrigerator. The weight of the turkeys ranged from 11.7 to 25.5 pounds. Hence, they would take different times to cook. The carcasses were thoroughly washed, dried with a paper towel, and were stuffed with stuffing prepared using a standard recipe formulation. Cultures of *Staphylococcus aureus*, *Salmonella typhimurium*, and *Clostridium perfringens* were added to the stuffing of two turkeys. The population of each organism ranged from 100,000 per gram to 10,000,000 per gram of stuffing.

The stuffed turkeys were placed in a preheated, 350°F oven and baked for 1 hour. A cooking curve for a 29-lb. turkey is shown at Figure 1 (Eckner, et al., 1988).

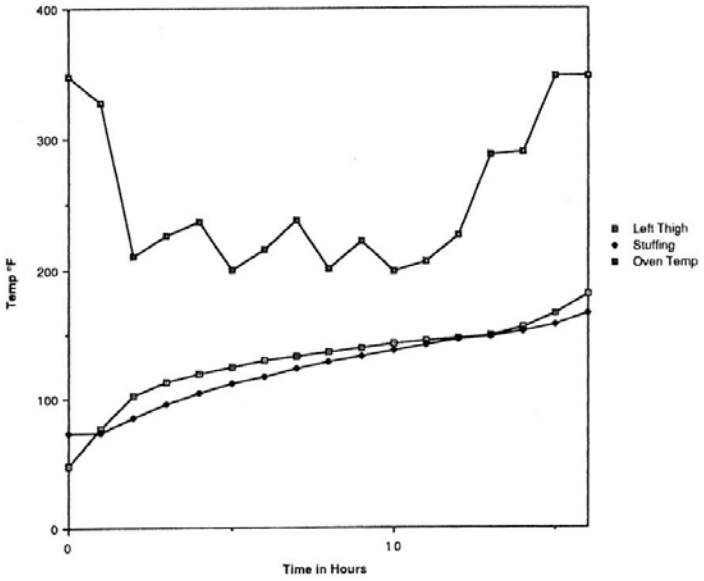

Figure 1. Rate of heat penetration at the slowest heating points in 29-lb. turkey

The temperature of the oven was then reduced to 225°F, and the turkeys were roasted an additional 12 hours. If the juice of the turkeys was pink. The turkeys were roasted an additional 1 to 2 hours at 300°F, or 1 hour at 350°F. A critical fact was that the final temperature of the stuffing was 165°F. The longest time between start of cook and getting to above the safe temperature of 130°F for the slowest cooking / largest turkey was about 8 hours.

As expected, no salmonellae or staphylococci was recovered. They were killed above 130°F as the turkey was cooking. Actually, if the stuffing had been sampled at 140 to 150°F, they would have found that these organisms would be dead, considering that 140°F for 12.7 minutes gives a 7D reduction of *Salmonella* in beef.

At the end of cooking, the stuffing and turkey were still positive for *C. perfringens*, as expected. Temperatures above 130°F are lethal for salmonellae and staphylococci, as these are vegetative pathogens. However, the spores of *C. perfringens* survive 165°F. Some of the *C. perfringens* spores may germinate to vegetative cells during a slow cook, but vegetative *C. perfringens* is very easy to inactivate. Therefore, when the turkey reaches 140°F, the vegetative *C. perfringens*, if produced, is destroyed. Once cooked, the turkeys cooked in this manner would be safe as long as they are above 130°F. Of course, uneaten portions of the stuffing (and turkey) must be handled properly to prevent *C. perfringens* "toxinfection" from the outgrowth of the spores during inadequate hot holding below 130°F or cooling too slowly to refrigeration temperatures.

How long does one have in cooking to get above the safe temperature of 130°F? Willardsen et al. (1978) reported on the multiplication of the *C. perfringens* vegetative cells in precooked hamburger during slow come-up in cooking. If the time to go from 50 to 130°F was about 7.6 hours, the vegetative cells might multiply 10,000 to 1. If the time was 5.8 hours, the multiplication would be about 1,000 to 1. If the time was 3.5 hours, the multiplication would be about 10 to 1. So, slow cooking might permit *C. perfringens* vegetative cell multiplication. By the time the hamburger reached 140°F, all of the *C. perfringens* vegetative cells that had multiplied will be destroyed. They used *C. perfringens* strains that multiplied about one every 7.5 minutes at 113°F. Common illness strains multiply more like once every 15 minutes at 113°F. Hence, this experiment was looking for extremes of safety. The times would probably be twice that reported for more "normal" *C. perfringens*.

From a HACCP perspective, what would be our concern? It would be toxin production from *S. aureus* growth during cooking. However, in raw turkey / food, *S. aureus* does not multiply, because there are competitive spoilage microorganisms. Therefore, with raw turkey, it would not multiply during cooking. Even if it did, as on cooked turkey with 100 S. aureus per gram, which was slowly reheated, the fastest I have found *S. aureus* to multiply is about once every 20 minutes in milk--3 times slower than the *C. perfringens* experiment by Willardsen et al. *Staphylococcus aureus* would have to multiply at least 1,000 to 1, or 10 generations, to make enough toxin to make anyone ill. The danger time to go from 50 to 130°F in cooked food starting with 100 *S. aureus* per gram would be expected to be approximately 3 times that of *C. perfringens*, or 15 hours. Note, this shows that the FDA-required food reheating to 165°F and holding for 15 seconds in less than 2 hours has absolutely no scientific validity. There is a small reason to set a minimum time for raw food cook come-up, but no justification for reheating as a safety control.

It is true that there is a phenomenon whereby *Salmonella* can double or triple in resistance to inactivation if it spends some time at about 110F, which it will during slow cooking. However, it makes no difference; 12.7 minutes at 140°F gives a 10,000,000-to-1 kill (7D reduction). Assume that the time becomes 45 minutes. During slow cooking, the food still spends plenty of time at lethal temperatures above 130°F to kill all vegetative pathogens.

As a final point, remember, the code says that raw, potentially hazardous food must be held at 41F. There is no science for any temperature by itself. There must be time factored in, because *Listeria monocytogenes, Yersinia enterocolitica* , and *Aeromonas hydrophila* all begin to grow at 29.3°F. If we choose 7 days at 41°F as a control, which actually allows for about 10 multiplications of *L. monocytogenes* in 7 days, or if 45°F, 4 days, or if 50°F, 2.4 days, and if 110°F, 4.5 hours, all of these times and temperatures allow for the same amount of growth (Snyder, 1998). When we use HACCP in retail food operations, no one needs to measure the refrigerators again in terms of raw food hazard control. The vegetative pathogens will be killed in cooking.

There is getting to be an extensive body of science indicating that below about 55 to 60°F, food "spoils safe." The FDA has provided no justification for imposing a raw food 41°F cold-holding temperature. Epidemiological experience of the last 100 years suggests that food held at 55 to 60°F has limited pathogen growth and spoils safe. There are many quality reasons for keeping raw food at 28 to 32°F. However, this is shelf life and quality, and not safety.

References:

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