Hazard Analysis and Control of Roast Beef Jus Preparation in Foodservice Establishments

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ABSTRACT

Roast beef and its jus prepared in foodservice establishments are often implicated as vehicles of foodborne illness. Preparation practices that could contribute to survival or growth of foodborne disease bacteria were examined. Temperatures were reached during cooking that would kill vegetative forms of these organisms. Prolonged holding of cooked jus on ranges with the heat turned off or on table tops created conditions in which spores could germinate and vegetative cells multiply. Conditions prevailed during cooling that could promote bacterial growth. Reheating jus to the boiling point would kill any vegetative forms that had multiplied during storage.

Roast beef and its gravy or juice (jus) are often vehicles of foodborne disease outbreaks (3,8,9). Bacterial spores are on raw meat surfaces and come off in the juice during thawing, storage and cooking. They are found in dehydrated jus and gravy mixes (4,5). Spores and vegetative bacteria that are on inside surfaces of containers reach jus and gravy when they are prepared or stored in such containers (4,5). Beef jus is an ideal medium for Clostridium perfringens and a good medium for other foodborne pathogens such as Staphylococcus aureus and Salmonella. After jus is cooked in large stock pots, anaerobic conditions (which are necessary for C. perfringens and can be tolerated by the facultative Salmonella and S. aureus) exist (1,2). When these conditions occur, time-temperature abuse of jus can lead to outbreaks of foodborne illness (3,17).

This study was undertaken to assess the foodborne disease hazards of beef jus under a variety of conditions of preparation - cooking, hot storage, cooling and reheating - in foodservice establishments and to suggest methods for controlling these hazards.

MATERIALS AND METHODS

The foodservice operations surveyed and specific equipment used are described in a previous paper (6). Soldered-end thermocouples were arranged so that their sensors were in the geometric center of jus during preparation, storage and serving.

RESULTS

Time-temperature data for cooking, hot-holding, and reheating the jus are listed in Table 1 and examples are illustrated in Fig. 1-3. Temperatures exceeding 93.3 C (200 F), frequently as high as the boiling point of the jus, were reached during cooking or reheating. Time-temperature data for cooling the jus in stock pots are given in Table 2 and an example is illustrated in Fig. 4.

DISCUSSION

Large volumes of jus heat slowly. Observations made in this investigation showed that the jus reached temperatures that would be lethal for vegetative bacteria during both initial cooking and reheating. After boiling, but staying on the range with heating elements turned off, the jus cooled slowly, remaining above 50 C (122 F) for a few hours, but eventually reaching temperatures at which foodborne pathogenic bacteria can multiply, sometimes remaining for several hours at optimal temperatures for growth of these organisms.

Even when refrigerated, large volumes of jus cool quite slowly, as do large volumes of other liquids (5,7,10,11,16,17). The temperature of jus refrigerated in gallon jars, deep pans, or large stock pots frequently remained within temperature ranges conducive to the growth of foodborne disease bacteria for several hours and were optimum for growth for much of this period. Under these conditions and those cited above, foodborne disease bacteria, if present, could increase to enormous numbers and, if enterotoxigenic, produce enterotoxins. (See reference 6 for discussion of bases for estimating survival and growth potential.)

Beef jus will no longer be a vehicle of bacterial foodborne disease if the following rules are followed: (a) avoid prolonged (several hours) storage of cooked jus on ranges with heat turned off, at room temperature, or in warming devices which hold it within a range that promotes bacterial growth; (b) do not store jus in large stock pots (5,11); (c) chill jus rapidly by (i) cooling in a pan set in ice in another pan (6), (ii) submerging the pan of jus in a water bath (5,13), (iii) packing in bags and cooling in chilled water (16,17), and (iv) whipping jus in a vertical mixer (5,10,12,14); (d) reheat, with occasional stirring, cooled jus on a range to at least 73.9 C (165 F), preferably to boiling, because an end-point temperature of 73.9 C (165 F) is difficult to measure during food preparation (5), or reheat in a steamer for sufficient time (16). Rapid cooling and thorough reheating are the most critical steps in preparing jus or gravy without risk of its becoming a vehicle of foodborne disease.
### Table 1. Time-temperature exposure of jus during cooking, reheating, and storage.

| Preparation step | Minutes from 100°F (‘F) to 150°F (‘F) | Minutes from 150°F (‘F) to 160°F (‘F) | Minutes from 160°F (‘F) to 170°F (‘F) | Minutes from 170°F (‘F) to 180°F (‘F) | Minutes from 180°F (‘F) to 190°F (‘F) | Minutes from 190°F (‘F) to 200°F (‘F) | Minutes from 200°F (‘F) to 210°F (‘F) | Minutes from 210°F (‘F) to 220°F (‘F) | Minutes from 220°F (‘F) to 230°F (‘F) | Minutes from 230°F (‘F) to 240°F (‘F) | Minutes from 240°F (‘F) to 250°F (‘F) | Minutes from 250°F (‘F) to 260°F (‘F) | Minutes from 260°F (‘F) to 270°F (‘F) | Minutes from 270°F (‘F) to 280°F (‘F) | Minutes from 280°F (‘F) to 290°F (‘F) | Minutes from 290°F (‘F) to 300°F (‘F) | Minutes from 300°F (‘F) to 310°F (‘F) | Minutes from 310°F (‘F) to 320°F (‘F) | Minutes from 320°F (‘F) to 330°F (‘F) | Minutes from 330°F (‘F) to 340°F (‘F) | Minutes from 340°F (‘F) to 350°F (‘F) | Minutes from 350°F (‘F) to 360°F (‘F) | Minutes from 360°F (‘F) to 370°F (‘F) | Minutes from 370°F (‘F) to 380°F (‘F) | Minutes from 380°F (‘F) to 390°F (‘F) | Minutes from 390°F (‘F) to 400°F (‘F) | Minutes from 400°F (‘F) to 410°F (‘F) | Minutes from 410°F (‘F) to 420°F (‘F) | Minutes from 420°F (‘F) to 430°F (‘F) | Minutes from 430°F (‘F) to 440°F (‘F) | Minutes from 440°F (‘F) to 450°F (‘F) | Minutes from 450°F (‘F) to 460°F (‘F) | Minutes from 460°F (‘F) to 470°F (‘F) | Minutes from 470°F (‘F) to 480°F (‘F) | Minutes from 480°F (‘F) to 490°F (‘F) | Minutes from 490°F (‘F) to 500°F (‘F) | Minutes from 500°F (‘F) to 510°F (‘F) | Minutes from 510°F (‘F) to 520°F (‘F) | Minutes from 520°F (‘F) to 530°F (‘‘F) | Minutes from 530°F (‘F) to 540°F (‘F) | Minutes from 540°F (‘F) to 550°F (‘F) | Minutes from 550°F (‘F) to 560°F (‘F) | Minutes from 560°F (‘F) to 570°F (‘F) | Minutes from 570°F (‘F) to 580°F (‘F) | Minutes from 580°F (‘F) to 590°F (‘F) | Minutes from 590°F (‘F) to 600°F (‘F) | Minutes from 600°F (‘F) to 610°F (‘F) | Minutes from 610°F (‘F) to 620°F (‘F) | Minutes from 620°F (‘F) to 630°F (‘F) | Minutes from 630°F (‘F) to 640°F (‘F) | Minutes from 640°F (‘F) to 650°F (‘F) | Minutes from 650°F (‘F) to 660°F (‘F) | Minutes from 660°F (‘F) to 670°F (‘F) | Minutes from 670°F (‘F) to 680°F (‘F) | Minutes from 680°F (‘F) to 690°F (‘F) | Minutes from 690°F (‘F) to 700°F (‘F) | Minutes from 700°F (‘F) to 710°F (‘F) | Minutes from 710°F (‘F) to 720°F (‘F) | Minutes from 720°F (‘F) to 730°F (‘F) | Minutes from 730°F (‘F) to 740°F (‘F) | Minutes from 740°F (‘F) to 750°F (‘F) | Minutes from 750°F (‘F) to 760°F (‘F) | Minutes from 760°F (‘F) to 770°F (‘F) | Minutes from 770°F (‘F) to 780°F (‘F) | Minutes from 780°F (‘F) to 790°F (‘F) | Minutes from 790°F (‘F) to 800°F (‘F) | Minutes from 800°F (‘F) to 810°F (‘F) | Minutes from 810°F (‘F) to 820°F (‘F) | Minutes from 820°F (‘F) to 830°F (‘F) | Minutes from 830°F (‘F) to 840°F (‘F) | Minutes from 840°F (‘F) to 850°F (‘F) | Minutes from 850°F (‘F) to 860°F (‘F) | Minutes from 860°F (‘F) to 870°F (‘F) | Minutes from 870°F (‘F) to 880°F (‘F) | Minutes from 880°F (‘F) to 890°F (‘F) | Minutes from 890°F (‘F) to 900°F (‘F) | Minutes from 900°F (‘F) to 910°F (‘F) | Minutes from 910°F (‘F) to 920°F (‘F) | Minutes from 920°F (‘F) to 930°F (‘F) | Minutes from 930°F (‘F) to 940°F (‘F) | Minutes from 940°F (‘F) to 950°F (‘F) | Minutes from 950°F (‘F) to 960°F (‘F) | Minutes from 960°F (‘F) to 970°F (‘F) | Minutes from 970°F (‘F) to 980°F (‘F) | Minutes from 980°F (‘F) to 990°F (‘F) | Minutes from 990°F (‘F) to 1000°F (‘F) |

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<th>Final</th>
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<td>Reheating</td>
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**Figure 1.** Temperature of approximate geometric center of 10 gallons of jus while being cooked on an electric range and then held on the same range without additional heating.

**Figure 2.** Temperature of the approximate geometric center of 10 gallons of jus while being cooked and held on a gas range and of 1/2 gallon that was held at room temperature.

**Figure 3.** Temperature of the approximate geometric center of 8 gallons of jus and the geometric center of a 12-pound roast while being reheated together on a gas range.

### References

Van Os and Beukers, *con't from p. 511*

this syringe in a first screening hardly affects the number of samples to be confirmed by retesting. By making use of the Micropettor syringe the number of samples that can be investigated per person has been found to be around 400 per hour.

REFERENCES


Bryan and McKinley, *con't from p. 513*

**TABLE 2.** Time-temperature exposure of jus during storage in stock pots in walk-in refrigerators.

| Container diameter (inches) | Approximate height of jus (inches) | Cooling period (min) | Refrigerator temperature (F) | Initial temperature (F) | Final temperature (F) | Minutes from 70 to 110°F | Minutes from 60 to 122°F | Minutes from 45 to 140°F | Potential for growth of foodborne disease bacteria
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<td>63</td>
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<td>49</td>
<td>170</td>
<td>280</td>
<td>&gt;660</td>
<td>++</td>
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1A +++ indicates expected multiplication reaching large numbers; a +++ indicates expected multiplication reaching very large numbers (outbreak potential).

Figure 4. Temperature of the approximate geometric center of approximately 5 gallons of jus while stored in a walk-in refrigerator.