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MEMORANDUM NOTE DE SERVICE

To/A	Anne-Marie St. Laurent BFRIIA Health Protection Branch Tunney's Pasture Ottawa, ON.	Security Class/Classe de sécurité Our File-N/Référence HRA 643
From/ De	Evaluation Division Bureau of Microbial Hazards 2204A1 Sir Frederick Banting Research Centre	Your File-V/Référence Date Wednesday 22nd December, 1999.

Subject
Objet **Health Risk Assessment:** Reheating Refrigerated Foods for Microbiological Safety

Please note that this HRA and any recommendations presented herein are specific to the situation described below, unless otherwise stated.

Situation Summary

In the Winnipeg hospital system, food is obtained from federally registered plants where the food is processed and frozen in bulk quantities. The food is then shipped to a central location for defrosting (walk-in coolers at 3°C), portioning and then distribution to hospitals in refrigerated carts and trucks. Processing at the federally registered plants is as follows:

(1) Meat products are cooked, packaged and frozen under a HACCP program.

(2) Soups are prepared, cooked, and packaged inn plastic containers and frozen. These containers are not vacuum packed.

(3) Vegetables are blanched, packaged and frozen in vacuum packed plastic bags.

The products are then frozen in bulk for storage. When needed, the product is shipped to a central location for defrosting (walk-in coolers at 3°C). The food is then plated onto hospital trays and refrigerated for shipping in specialty chill/heat carts. At the hospital, the carts are kept refrigerated until approximately 45 to 50 minutes before mealtime. Reheating takes approximately 45-47 minutes and the food is served within a short time period of 15-30 minutes after heating. The food is heated to a minimum internal temperature of 74°C. The institution is seeking a relaxation of temperature for reheating to 70°C from the regulatory requirement of 74°C for reheating foods.

Risk Assessment

Risk Assessment is composed of four elements: Hazard Identification, Exposure Assessment, Hazard Characterization and Risk Characterization (Estimation).

Hazard Identification

The cooking of the food during processing at the federally inspected plants renders the food ready-to-eat (RTE). The microbiological hazards which may occur are due to post-process contamination. The literature reports that *Staphylococcus aureus*, *Clostridium perfringens*, *Bacillus cereus* and *Listeria monocytogenes* are commonly involved in food-poisoning outbreaks involving food that is reheated.

Exposure Assessment

Exposure assessment involves an estimation of the likelihood of occurrence and potential concentration of the pathogen /toxin in the food at the time of consumption. The effect of heating the product to a minimal internal temperature of 74°C on the organisms of concern can be quantitated using the D value of the organism at 74°C. The D_{60} values in a conduction heating food for *Staphylococcus aureus* has been reported to be 3minutes, *Listeria monocytogenes* to be 4 minutes, while the D_{124} for *Bacillus cereus* spores was reported to be 7 minutes and for *C. perfringens* spores the D_{100} has been reported to be 20 minutes,(vegetative cells D_{60}=14.5 minutes) (1). Therefore an internal temperature of 74°C has minimal effect on spores of *C. perfringens* or *B. cereus* but will have an effect on all vegetative cells. From above, the vegetative cells of *C. perfringens* and *B. cereus* are the prime organisms of concern and have similar heat resistances. The D_{74} was calculated to be 0.022 mins. which results in a log reduction of 45 for every minute at 74°C. Therefore this process renders the food safe to eat because the likelihood of occurrence of the organism or toxin after cooking to this temperature is negligible. The D_{70} for vegetative cells of these two organisms was calculated to be 0.15 mins. and this results in a log reduction of 6 for every minute at 70°C. Therefore heating to 70°C could result in an unacceptable increased risk of foodborne illness unless steps are taken to minimize post-process contamination or unless the product is held for at least 8 minutes at 70°C.

Dose- Response Asessment

Staphylococcus aureus causes foodborne illness as an intoxication. Less than 1 µg of toxin can result in illness. This toxin level is usually achieved when *S. aureus* populations exceed 10^6 per gram of food (2). Following cooking, in the absence of proper cooling, spores of *Clostridium perfringens* are able to germinate and their numbers can increase. The minimum infectious dose has been $\geq 10^5$ *C. perfringens* /g in implicated food (2). The minimum infectious dose for *Bacillus cereus* is greater than or equal to 10^5 organisms /g of food (1,2). Infections due to *Listeria monocytogenes* are thought to be due to > 100 viable cells of the organism (1). Therefore cooking to an internal temperature of 74°C should not allow these conditions to develop. As mentioned earlier, holding at 70°C for a minimum of 8 minutes would be considered equivalent to 1 minute at 74°C.

Hazard Characterization

This provides a description of the severity and duration of adverse effects that may result from ingestion of a microorganism or its toxin in the food.

Staphylococcus aureus, Clostridium perfringens and *Bacillus cereus* all result in gastrointestinal illnesses (2, 3). Symptoms associated with ingestion of *S. aureus* and its preformed enterotoxins occur within 2-4 hours (2,3). Mortality rate is extremely low with occasional death occurring in elderly individuals (2). Illness due to *B. cereus* occurs within 8-16 hours, due to ingestion of large numbers in food and mortality is extremely low (2, 3). Nausea, vomiting, diarrhea, abdominal pain are predominant with both illnesses. Though all individuals are susceptible to acquiring staphylococcal food poisoning or intoxication due to *B. cereus,* incubation periods can vary depending on the sensivity of the target population (eg. children, immunocompromised individuals, the elderly are more susceptible). An incubation period of 10-12 hours for *C. perfringens* results in mainly abdominal cramps and putrefactive diarrhea (3). Death is uncommon, occurring only in the elderly, debilitated or institutionalized individuals. The incubation period for listeriosis from *L. monocytogenes* appears to vary from a few days to three weeks. Gastrointestinal symptoms such as nausea vomiting and diarrhea may preceed more serious forms of listeriosis or can be the only symptoms occurring. Full-blown diseases such as meningitis, septicemia and abortion are typical. The disease is associated with a high mortality rate in the elderly, the immunocompromised and perinatal cases(1).

Hazard Exposure Characterization

This parameter is used to determine the size of the Canadian population at risk. The population at risk is considered to be the number of people who may consume the food which has the potential to be contaminated. These RTE reheated foods are to be ingested by a very sensitive population in a public hospital, comprising of immunocompromised individuals, the elderly and sick children. Reheating foods to an internal temperature of 74°C is considered an effective thermal process that would offer very adequate protection against transmission of foodborne pathogens to such a weakened sector of the population. Therefore the likelihood for gastroenteric illnesses or listeriosis from the RTE foods reheated to 74°C in this sector of the Canadian population, is negligible. To achieve the same objective, the food should be held at an internal temperature of 70°C for a minimum of 8 minutes.

Risk Characterization(Estimation)

This involves estimating the likelihood of occurrence of hazards in the RTE food at 70°C as compared to 74°C. For illness to result, the following sequence of events are expected to occur:

1) The product must be contaminated with viable counts of vegetative cells/ toxin of the pertinent pathogenic hazards mentioned above, prior to reheating. Post-process contamination can occur at the portioning/ plating stage of this food service operation, thereby facilitating this event. In addition, it is accepted that spores of *C. perfringens* and *B. cereus* can persist in the initially cooked food.

2) The cells or spores must survive the food-processing treatment. The likelihood of occurrence of the organism or toxin is negligible at 74°C since this achieves a log reduction of 45 for every minute at 74°C. However, a log reduction of only 6 for every minute results when a food is reheated to 70°C. The latter could be overcome by holding the product at an internal temperature of 70°C for at least 8 minutes.

3) The organism must be capable of growing in the product after reheating. At 70°C, none of the identified pathogens is expected to grow.

4) At the time of ingestion, the food must be contaminated with toxin/organisms above the values

specified in the Dose Response Assessment. We do not expect this to occur if the product is heated to 70°C and held for a minimum of 8 minutes.

Based on these four events, reheating foods to an internal temperature of 70°C with a minimum holding time of 8 minutes should offer the same level of safety as 74°C for 1 minute.

Nature of Health Concern
This is the category of health risk determined relative to the HPB summary. There is little health risk associated with reheating RTE foods to an internal temperature of 70°C with a minimum holding time of 8 minutes.

HPB Interpretative Summary
The Interpretive Summary states guidelines for Heat-and-Serve products (Dry mixes) and RTE spices. The presence of *C. perfringens*, *B. cereus* or *S. aureus* above the limiting values specified, indicates a health 2 concern.

References
(1) ICMSF 1996. Microorganisms in Foods 5. Characteristics of Microbial Pathogens, p. 28, 121, 157, 310. Blackie Academic & Professional, London.

(2) Health and Welfare Canada, 1989. Foodborne Pathogenic Microorganisms. Microbiology Research Division, Health Protection Branch, Tunney's Pasture, Ottawa.

(3) Frazier and Westhoff, 1988. Food Microbiology. 4th Ed. pp. 467-9. McGraw-Hill Book Company, Singapore.

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