Module 2-6 Principles of Thermal Processing

Canning is the process of placing food in a container and hermetically sealing it so that is airtight and impervious to the entrance of microorganisms and then giving it a thermal process has been practiced since around 1810.

One of the key components that affect the sterilization of the canned products is temperature, which is easily regulated. Temperature is also one of the critical elements that would be included on the process schedule.

To develop the process schedule, the processing authority needs extensive knowledge of food microbiology, characteristics of the product, container, and the thermal processing system.

The processing authority must have the ability to recognize the limitations of the processor and/or the processing system.

Components of the process schedule include initial temperature of the product, process time, process temperature, product type, container type, and the thermal processing system. Critical factors may include minimum headspace and maximum thickness and maximum pH for acidified products.

Thermal processes are developed using scientific procedures that consider: 1) the heat resistance of the microorganism to be destroyed and 2) the heat penetration into the product. The target microorganisms for LACF include *Clostridium botulinum* and *C. sporogenes.* For acidified LACF, the target microorganisms are vegetative cell of pathogens and acid tolerant non-pathogenic spores.

The heat resistance of microorganisms can be dependent on several factors including, growth characteristics of the target organism, media organism grows, and the conditions under which the organism grows. In order to determine the heat resistance of microorganisms, thermal death time studies must be conducted. These studies can be conducted using a three-neck flask, thermal death time tube, and many retorts. The microbiological parameters to determine the thermal death time study include the D value, Z value, and F value.

The D value refers to the time, at a constant temperature, required to kill 90% of the organism's present.

The Z value is the change in temperature that changes the devalue by a factor of 10 or organisms heat resistance by a factor of 10.

The F value is the number of minutes at a given temperature necessary to destroy a given number of microorganisms.

The product heating data can be determined by conducting heat penetration test. The heat penetration tests monitor the rate of change in temperature of the food inside the container as it is being heated in a specific retort system. Temperature sensor or thermocouple located in the product at the slowest heating region (cold spot) of the container. The slowest heating region or container cold spot depends on the product type, container size and type, the thermal processing method or system, and the heat transfer mechanism. These heat penetration tests are used to simulate the worst-case scenario likely to occur when producing the product. There are several potential critical factors possible that effect the heat penetration test such as raw or cooked meat, moisture content, clumping of the product, particle size and style, solid to liquid ratio, fill weight, etc. To determine the cold spot the processing authority would also have to know the heat transfer mechanisms. These mechanisms include convection, conduction, convection and conduction, and induced convection. Conduction heating is defined as particle to particle heat transfer with no particle movement. Convection heating is defined as particle two particle heat transfer with particle movement. Induce convection heating is the mechanical agitation which creates product movement to enhance convection heating of the product. A thermocouple is

used to monitor the temperature inside of the container during processing. The thermocouple must be in the slowest heating region or cold spot of the container. Mounting must place an maintain thermocouple at the desired location. The thermocouple may need to impale the product in order to determine the cold spot.

After determining the thermal resistance data for the target organism and the heat penetration data for the product, the process authority can then use a scientific method to calculate the process schedule for the product. The purpose of a process schedule calculation is to demonstrate that the thermal process can deliver the required lethality. It also determines how changes in the product formula preparation parameters or filling affects the lethal treatment. There are two scientific methods for determining process schedules that will achieve the sterilization value (F_0) for a given product the general or graphical method and the formula method. Using the general method, lethality is calculated directly from the heat penetration time and temperature data using a Z value of 18ºF and the reference temperature of 250 ºF. The most common formula method is the ball formula method. The Ball formula method was developed by C. Olin ball in 1923. After the process schedule has been developed, confirmation can be determined by a inoculated test pack.

Heat distribution (HD) and temperature distribution (TD), test determine temperatures around containers in retort systems. Processing authority and equipment manufacturers use HD/TD test to develop retort operating schedules such as the venting schedule and retort come up time. Process timing must not start until the retort temperature in the process schedule is achieved and required retort operating procedures are completed.