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HACCP Verification Procedures - Validation of Blue Crab Retort Processes

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Processors in the state of Virginia that cook whole crabs and pick the meat for sale must be certified by Virginia Department of Health/Division of Shellfish Sanitation (DSS). They also are required to develop and implement a Hazard Analysis Critical Control Point (HACCP) plan as part of the seafood HACCP regulation. Processors who sell fresh crabmeat must identify the retort cook step as a HACCP Critical Control Point (CCP), and validate the retort cooking step to ensure that the equipment is working and the established parameters are consistently followed. A CCP is defined as a step in the process at which control must be applied to prevent, eliminate, or reduce a hazard to an acceptable level. At each CCP, Critical Limits (CLs), which are maximum and/or minimum values, are established. When real-time monitoring of CCPs indicates that CLs are violated, specific corrective actions are taken to bring the process back into compliance.

Fig. 1. Cooked blue crabs.

What is a retort cook process validation?

A retort cook process validation is a scientific study that evaluates heating times, internal product temperatures, and environmental temperatures to verify that the heating process used to cook the crabs is adequate to destroy harmful microorganisms. In the case of a crab retort process, a validation study establishes process parameters to ensure that a 6 $\log_{10}$ reduction of *Listeria monocytogenes* is achieved.

What is Listeria monocytogenes?

L. monocytogenes is a bacterium that can cause consumer illness. It is the most heat resistant vegetative pathogen, and it is found throughout the seafood plant processing environment.

The FDA has established a zero defect action level (<1 CFU/25g) for *L. monocytogenes* in ready to eat fish or shellfish products. No detectable *L. monocytogenes* are allowed in ready to eat or fully cooked products such as crabmeat.

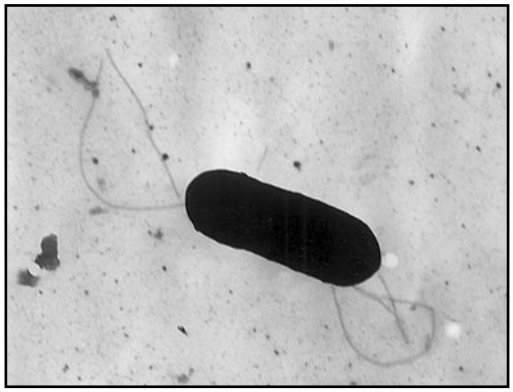

Fig. 2. Electron micrograph of a rod-shaped *Listeria monocytogenes* bacterium.

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How is a crab retort validation performed?

A validation study is conducted on a case-by-case basis. Thermocouples (a type of temperature sensor), are positioned in and amongst the crabs at different locations in the retort. These thermocouples measure the internal meat temperatures as well as the retort temperatures achieved over the entire time of the cooking process. The retort thermometer temperature readings are also visually monitored and later compared against the vessel ambient thermocouple results.

As the retort temperature increases, the crabs heat up and bacterial destruction takes place. After the end of the measurement period, these data are transferred to a computer for analysis. The results are used to determine the adequacy of the cooking process for destroying *L. monocytogenes*.

Fig. 3. A live blue crab with attached thermocouple is placed in steel basket before retorting begins.

Retort validation results

The result of the validation study determines if a 6 $\log_{10}$ reduction is achieved based on the calculated F-value. The FDA requires that the retort cooking process results in a 6 $\log_{10}$ or 1-million-fold reduction of *L. monocytogenes* in the cooked crabs.

The F-value represents the destruction of *L. monocytogenes* in terms of equivalent time at a specific reference temperature (185°F) and a set z-value that results in microbial destruction. The z-value shows the impact of different temperatures on microorganisms; a small z-value means that a relatively small increase in temperature results in a greater increase in the destruction of the target organism. The F-value can be correlated to a D-value, or death rate, which is the amount of time at a constant temperature that it takes to reduce the population of bacteria by 1 log (i.e. a factor of 10). Once this F-value is calculated and correlated to a D-value, the processing parameters for the retort cooking step can be established.

Benefits of a validation study

Because processors rely only on the retort temperature, pressure, duration of cooking, and cooling times, and not the internal temperature of the crabs, a validation study is needed to establish processing parameters required to achieve a 6 $\log_{10}$ reduction of *L. monocytogenes*. The processor then follows those established retort cooking parameters.

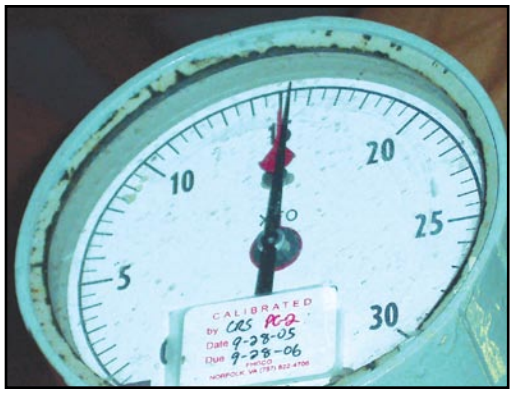
Fig. 4. Workers pick meat from cooked blue crabs, paying careful attention to maintain a sanitary environment.

Studies at Virginia Tech have shown that many retorts achieve a 6 $\log_{10}$ reduction or more of *L. monocytogenes* during the retort temperature come-up time period when temperatures reach 240° to 250°F. When a 6 $\log_{10}$ reduction of *L. monocytogenes* occurs during the retort temperature come-up time, the CL is the temperature at which this reduction occurs. If a 6 $\log_{10}$ reduction is not achieved during the come up time, processors may be required to continuously monitor retort cook times and temperatures using automatic time/temperature continuous monitoring equipment.

What happens when validation results show that internal product temperature has not been met?

Equipment and/or procedures that fail to provide the adequate temperature must be modified or adjusted to achieve a 6 $\log_{10}$ reduction of *L. monocytogenes*. There are many reasons for failure such as improper functioning of the boiler, a non-calibrated retort thermometer, stuck steam valve, improper venting, etc. Ensuring that the retort thermometer is calibrated is of utmost importance. Without a calibrated thermometer, it cannot be ensured that the proper retort temperature is achieved[1].

[1]Information on thermometer calibration can be found in *Retort Thermometer Protocol*, Virginia Cooperative Extension publication 458-871, and Virginia Sea Grant College Program publication number VSG-95-06.



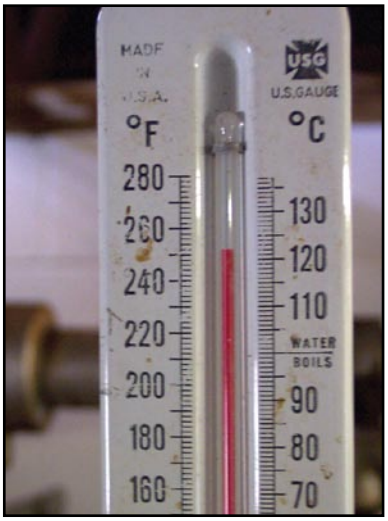


Fig. 5 and 6. Retort pressure gauges and thermometers are used by processors to measure pressures and temperatures inside the retort during the cook process.

HACCP Records

A validation letter is sent to the company with the results of the calculated F values including a description of the retort cooking process and whether or not a 6 $\log_{10}$ reduction of *L. monocytogenes* was achieved. The letter describes the validation process parameters such as the amount of crabs, initial crab temperature, and the required cooking process time and temperatures of the retort, and establishes CL for the retort cooking step. The processor then follows the established protocols and parameters for the retort cooking step to ensure elimination of *L. monocytogenes*.

This letter becomes part the HACCP verification records and needs to be kept on file and presented when requested to state and/or federal inspectors.

How often do I need to validate my equipment?

The retort process should be validated every time there is:

- A change or repair to the equipment, boiler, piping, or venting systems;
- A change in the pounds of product cooked per batch (processing of smaller batches can shorten the come-up time of the retort);
- A change of the cooking normal operating conditions.

Sea Grant Virginia

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