Lethality, Stabilization, and Multiple Hurdles Introduction

RTE-SS Inspection Course

Module Overview

Ready-To-Eat (RTE) foods: Hot Dogs, Deli Meats, Jerky (Meat or Poultry) are some examples.

Lethality (cooking) and Stabilization (generally, cooling) are two of the primary temperature preventive measures.

Besides temperature control there are other processes where safety depends on complex interactions between several preventive measures. We call this the multiple hurdles concept. Beef Jerky, Summer Sausage are two examples.

You will view a video that will explain some of the important elements to consider when inspecting RTE products.

You will learn about the pathogens of public health concern associated with RTE products. *Listeria monocytogenes (Lm), Salmonella, Clostridium perfringens, Clostridium botulinum to name a few.*

You will learn the difference between RTE and Not Ready-to-Eat (NRTE) products

Terminology

RTE-SS Course

Terminology

Lethality - the process used to destroy pathogens, most often cooking

Stabilization - the process used to prevent or limit the growth of spore-forming bacteria; often called cooling

Multiple hurdle concept - multiple treatments that used together achieve lethality or stabilization

Terminology

Performance Standard - quantifiable pathogen reduction levels or growth limits set by FSIS regulations

Targets - limits set by establishments to produce safe products in the absence of FSIS performance standards

Terminology

Water activity (aw) - the amount of free water in a product available to bacteria

Clostridium botulinum - spore-forming bacteria hazardous to public health due to its ability to produce the botulinum toxin, the most potent toxin known to mankind

Clostridium perfringens - a frequent target organism for *Clostridia* species because other spore formers are slower growing

Terminology

Compliance Guidelines - written by FSIS and focused on providing guidance and information to small and very small plants, compliance guidelines are not mandatory or regulatory and can be used to support CCP critical limits

Appendix A - guidance to assist processors that cook meat and poultry products in complying with HAACP regulatory requirements in 9 CFR 417

Appendix B - guidance to assist processors that produce heat-treated RTE and NRTE meat and poultry products in preventing or limiting the growth of spore-forming bacteria and other pathogens

Humidity - a critical parameter for lethality of pathogens, especially *Salmonella*

Terminology

Jerky Products

- Lethality (heating) - should achieve at least a 5.0 log reduction of *Salmonella* spp.
- Drying (stabilization) - reduces water activity to inhibit or prevent pathogen growth

Fermented Products

- Degree-Hours - a Good Manufacturing Practice that uses time and temperature controls to ensure that *Staphylococcus aureus* growth is limited when the temperature is more than 60°F during fermentation

Lethality, Stabilization, and Multiple Hurdles - Introduction

RTE-SS Inspection Course

Resources

You may want to open these resources for this topic:

FSIS Directive 7111.1 - Verification Procedures for Lethality & Stabilization

Cooking Guideline - Revised Appendix A

Stabilization - Revised Appendix B

Introduction to Lethality & Stabilization

The video on the next slide will describe important elements to consider when performing the Hazard Analysis Verification (HAV) task during verification reviews of the lethality and stabilization steps in an establishment's HACCP plan.

NOTE: 2017 Compliance Guidelines are pictured in the video. Establishments that use Appendix A and/or Appendix B for support are required after December 14, 2022 to have the revised 2021 versions of the compliance guidelines on file.

Public Health Concerns for RTE

FSIS considers all RTE products to be adulterated if they contain pathogens of public health concern or their bacterial toxins that can cause illness in humans.

- Any *Salmonella*, *Lm* and STEC
- *C. perfringens*
- Any *C. botulinum* growth

CCP's in RTE:

- CCPs must be at point in the process where adequate control can be applied.
- CCPs must be supported.

Scenario #1:

An establishment has documentation from 9 CFR 318.23 supporting the decision in their HACCP plan. The establishment's cooking step for uncured beef patties implements hold time and temperature critical limits that will reduce to undetectable levels the bacteria in raw beef trimmings used in the uncured beef patty production process. The cooking step will be considered a CCP in the uncured meat patty production process.

Answer the questions on the following slides:

Review Question

What record would the CSI look to review?

- Uncured Beef Patty Production Log
- Raw Meat Receiving Log
- Cooking Temperature Log

Scenario #2

An establishment documented the following decision at the chilling step: "The rate of chilling for our small diameter frankfurters, wieners, and hot dogs is important. Although the products are cooked sufficiently to destroy vegetative pathogens, low levels of *Clostridium* spp. spores may remain viable. These products chill quickly after cooking and are moved into holding coolers. If the product does not chill at the required rate, germination and outgrowth of microbial spores may occur.
Therefore, the rate of chilling is a food safety concern that will be addressed as a CCP in the product HACCP plan. By using Appendix B Option 3 as support for the cooling CCP, the temperature of the sausage products will be reduced at a rate well within FSIS's cooling guidelines for cured products."

Answer the questions on the following slide:

Review Question

What record would the CSI look to review?

- Raw Product Receiving Log
- Chilling Temperature Log
- Pre-Shipment Review Log

Lethality and Stabilization Performance Standards

Establishing Critical Limits

- HACCP plan design must meet regulatory requirements.
- Critical limits established at each Critical Control Point (CCP) must comply with **9 CFR 417.2(c)(3).**
- Instructions for inspection verification for lethality and stabilization are found in **FSIS Directive 7111.1.**

Terminology

- **Performance Standards:** Quantifiable pathogen reduction levels or growth limits set by FSIS regulations.
- **Targets:** Limits set by establishments to produce safe products in the absence of performance standards set by FSIS.

Lethality Performance Standard

Uses *Salmonella* as target organism.

Death of *Salmonella* indicates destruction of other vegetative pathogens.

No requirement to use any particular cooking time and temperature.

What is Log Reduction?

1-log Reduction = population reduced by 90% Expressed as “x-log” or "x-log10"

Log Reduction	Number of CFUs Remaining	Percentage Reduction
0 log	1,000,000	0%
1 log	100,000	90%
2 log	10,000	99%
3 log	1,000	99.9%
4 log	100	99.99%
5 log	10	99.999%
6 log	1	99.9999%

5-log Reduction
100,000 organisms
10,000
1,000
100
10
1

Stabilization Performance Standard

Spore-forming bacteria can survive cooking and grow during cooling.

- ***C. botulinum***

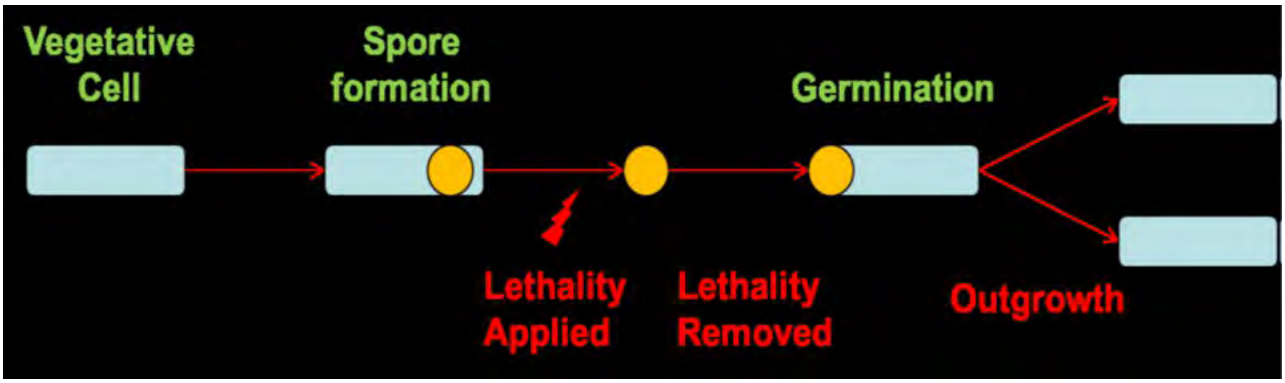
- ***C. perfringens***

Warm Product Provides Ideal Environment

- Products which are warm after cooking create an ideal environment for the growth of spore-forming pathogens. It is important to cool quickly between 130 to 80 degrees Fahrenheit.
- ***C. perfringens*** - optimal growth range during cooling is from 126°F down to 109.4°F.
- **Rapid cooling** of products will prevent growth of spore-forming bacteria.

Spore Formation, Germination, and Outgrowth

While cooking of meat and poultry products will destroy vegetative cells of bacteria like *Salmonella*, STEC, and *Lm*, bacteria like *C. perfringens* and *C. botulinum* form spores that may survive lethality treatments.



Curing Inhibits *Clostridium*

Cure (**nitrite**) and cure accelerators inhibits *Clostridium* growth.

Products Without Regulatory Performance Standards

- Establishments must address hazards that are likely to occur with a CCP.
- Establishments must identify in the HACCP system:
    - Lethality pathogen reduction target (e.g., 6.5-log reduction in *Salmonella*)
    - Stabilization outgrowth controls

Example: Regulatory Performance Standard

Cooked, Roast, Cooked Corned Beef

- **Lethality** = 6.5-log reduction in *Salmonella*
- **Stabilization** = no multiplication of *C. botulinum* and no more than 1-log increase of *C. perfringens*.

Fully Cooked Uncured Meat Patties

- **9 CFR 318.23 (b)(1) & (c)**
- **Lethality=** must meet time and temperature combinations in the regulation (which achieves a 5-log reduction of *Salmonella*).
- **Stabilization=** no multiplication of *C. botulinum* and no more than 1- log increase of *C. perfringens.*

Other RTE Cooked Meat Products

- **9 CFR 417.2(a)(1)**- No specific regulatory performance standard, must meet HACCP regulations.
- **Lethality**= FSIS recommends a 6.5 log reduction of *Salmonella* (or 5-log with additional support)
- **Stabilization**= FSIS recommends ≤ 1-log growth of *C. perfringens* (or ≤ 2-logs with additional support)

Example: NO Regulatory Performance Standard

RTE Shelf-Stable Meat Products

- When there are NO specific regulatory performance standards that apply to a certain product, then those processes must simply comply with the HACCP regulations.

Review Question - lethality performance standard

What is the lethality performance standard for cooked beef, roast beef, and cooked corned beef?

- A 1-log increase in C. botulinum
- A 6.5-log reduction in C. perfringens
- A 6.5 log reduction in Salmonella

Fully Cooked Poultry

Fully Cooked Poultry: 9 CFR 381.150

- **Lethality =** 7.0-log reduction in *Salmonella.*
- **Stabilization** = no multiplication of *C. botulinum* & no more than 1-log increase of *C. perfringens.*

RTE Shelf Stable Poultry Products: 9 CFR 381.150(a)(2)

- **Lethality =** 5.0-log reduction in *Salmonella.*

9 CFR 417.2- must meet HACCP regulations.

NRTE Partially Cooked/Char-Marked Meat Patties & Poultry Breakfast Strips

- **No lethality** required.
- **9 CFR 318.23(C)(1) and 9 CFR 381.150(b).**
- **Stabilization =** no multiplication of *C. botulinum* and no more than 1-log increase of *C. perfringens*.

Other Not Ready-To-Eat (NRTE)

- **No Lethality** required, will be cooked by the consumer
- **9 CFR 417.2 -**Must meet HACCP regulations
- **Stabilization =** FSIS recommends ≤1-log growth of *C. perfringens* (or ≤ 2-logs with additional support) Limit growth of *S. aureus* to ≤ 2.0 logs during processing

Review Question

What is the lethality performance standard for fully cooked poultry products?

- A 6.5 log reduction for S. aureus
- A 6.5 log reduction for Salmonella
- A 7.0 log reduction in Salmonella

Review Question

Do partially cooked and char-marked uncured meat patties need to meet a lethality performance standard?

- No
- Yes

Explanation: Because the meat patties are char-marked and fresh (uncured) as opposed to a cured meat patty product, the meat patties do not have or need to meet a performance standard. The product will also be further cooked by the consumer. However, the product package label should state that the product needs to be fully cooked by the consumer before consumption.

Lethality, Stabilization and Multiple Hurdles

FSIS Cooking Guidelines (Revised Appendix A)

RTE & Cooked Product Validation Compliance

- Establishments must decide how to design their process to control hazards.
- Establishments may use FSIS guidelines, published processes, or develop customized processes.
- **Important:** All critical operational parameters match the process and are implemented.
- **Must be validated!!**

FSIS Compliance Guidelines

- Provide guidance and information to industry.
- Not regulatory - not mandatory.
- May be used to support the selection of CCPs and critical limits in the HACCP plan, or critical operational parameters in a prerequisite program.

List of Important Guidelines

Cooking Guideline- Revised Appendix A

Stabilization Guideline-Revised Appendix B

Lebanon Bologna Compliance Guidelines

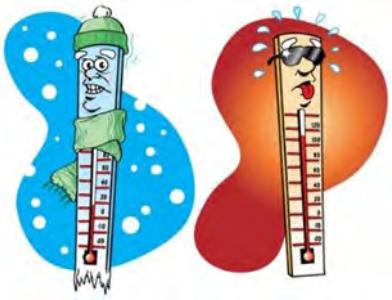
Jerky Compliance Guidelines

Lethality Guidelines

- Guidance for processors of cooked poultry products and cooked beef, corned beef, and roast beef to assist them in meeting FSIS's lethality performance standard.
- The guidelines are provided especially to small and very small establishments that produce RTE products.
- HACCP allows establishments the flexibility to develop unique and innovative processes to meet the food safety objective, i.e., in this case, a specified log10 reduction in *Salmonella*.

Appendix A

Time-Temperature-Humidity



Appendix A - Three Conditions

If the FSIS Lethality Guideline, known as Appendix A, is used as supporting documentation for the selection of CCPs and critical limits, **all** the conditions listed must be addressed.

Cooked Meat Table from Appendix A

- Contains time and temperature combinations for cooked beef that achieve the required 6.5-log reduction in *Salmonella*.
- Temperatures are internal product temperatures.
- Range from:
    - 112 minutes at internal temperature of 130°F, to
    - Instantaneous at 158°F

Review Question-Lets practice using the chart from Appendix A

How long must cooked beef be held at an internal temperature of 136°F to achieve a 6.5 log reduction in *Salmonella*?

- 8 minutes
- No holding time required
- 28 minutes

Other Processes May Use Appendix A

Appendix A can be used to support critical limits for cooking or heat treatment CCPs for other RTE meat, including pork.

Establishments that produce other types of RTE meat may use Appendix A to support their critical limits, times and temperatures, applied at the cooking or heat treatment CCPs in their HACCP plans.

Humidity - Appendix A

- **Humidity** is a critical parameter for lethality of pathogens, especially *Salmonella*.
- If not maintained:
    - Product surface won't heat as quickly
    - Product surfaces can dry out
    - Bacteria become more heat resistant

Options for Maintaining Relative Humidity

With a minimum internal temperature of 145°F:

- Introducing steam for 50% of the cooking time but not less than 1 hour.
- Sealing oven for 50% of the cooking time but not less than 1 hour.
- Introducing steam to achieve humidity at 90% for at least 25% of the cooking time, or 1 hour.

When Humidity Controls are Not Needed

Some processes inherently maintain required humidity:

- Immersing the product in the liquid cooking medium
  Cooking product in sealed, impervious bag
- Applying direct heat
- Cooking product in a casing that holds moisture (e.g., natural casings, cellulose casings, collagen casings, fibrous casings and plastic casings (sometimes called "synthetic" casings).

Humidity is not needed for large roasts, products that are 10 pounds or more, cooked at 250°F or higher, because they have a low surface to mass ratio, the surface dries slower and *Salmonella* is less likely to become heat resistant.

Appendix A- Heating Deviations

- Slow come-up times.
- Dwell times of more than 6 hours in the 50°F to 130°F range are dangerous because *S. aureus* can grow and produce toxin.
- The toxin is heat stable and cannot be destroyed by normal re-cooking.
- Establishments may use pathogen computer modeling programs and process authorities in determining the severity of the heating deviation and product disposition.

Instantaneous Temperatures for Poultry

Two internal temperatures to instantaneously achieve the required 7.0 log reduction in *Salmonella*:

- Uncured Poultry - 160°F
- Cured Poultry - 155°F

Time-Temperature Tables for Cooking RTE Poultry

- Contains time and temperature recommendations for chicken and turkey to achieve a 7.0- log10 reduction in *Salmonella*.
- Establishments should consider the use of humidity.
- The Poultry Time-Temperature Tables, included in the lethality compliance guidelines, provide establishments with time and temperature combinations that can be used to cook chicken and turkey products with 1 to 12% fat levels.

Time-Temperature Tables for Cooking RTE Poultry

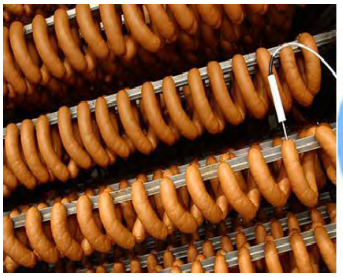
Addresses Fat content level (1-12%)

- Higher fat content the longer it takes the product to heat

Comparison Example

- Chicken with 7% fat cook - 160°F internal temperature for 15.3 seconds
- Appendix A - 160°F instantaneous

Lethality, Stabilization and Multiple Hurdles



Stabilization Guideline-Revised Appendix B

Resources for this topic

Click on each link below for additional resource information:

FSIS Directive 7111.1

Stabilization Guideline- Revised Appendix B

Appendix B - Cooling

Appendix B provides guidance for processors that cook meat and poultry products to meet FSIS's stabilization (cooling) performance standard.

Appendix B Includes 4 Cooling Options

Regardless of the option used:

- Cooling must be **continuous.**
- Rapid cooling is necessary to prevent growth of *Clostridia* bacteria.

There are several cooling options, which have different time and temperature combinations for cooling product.

Appendix B - Cooling Option 1

Cool the product from:

- **130°F to 80°F in 1.5 hours**
- **80°F to 40°F in 5 hours**

All fully cooked, cured and uncured, and partially cooked processes may use this option.

Appendix B-Option 1 Review Question

If an establishment is using Appendix B-Option 1, what is the total cooling time?

- 7.5 hours
- 5.0 hours
- 6.5 hours

Explanation: The total time would be 6.5 hours - 1.5 hours to go from 130°F to 80°F + 5 hours to go from 80°F to 40°F for a total of
6.5 hours.

Appendix B- Option 2

Start chilling product **within 90 minutes** of the end of cooking Cool product temperature from:

- **120°F to 80°F in 1 hour**
- **80°F to 55°F in 5 hours**

Continue chilling until 40°F

Fully cooked, cured and uncured processes may use this option

Appendix B- Option 2 Review Question

If the establishment is using Appendix B-Option 2, what is the total cooling time?

- 7.5 hours plus the time to 40 degrees
- 8.5 hours plus the time to 40 degrees
- 6 hours, plus the time to 40 degrees

Explanation: Start chilling within 90 minutes of the end of cooking: 120°F to 80°F + 80°F to 55°F, then continue chilling to 40°F or less for a total of 6+ hours.

Appendix B-Cured Products-Option 3

Fully Cooked *cured* product must have at least 100 ppm of ingoing sodium nitrite and 250 ppm erythorbate or ascorbate.

Cool the product temperature from:

- **130°F to 80°F in 5 hours**

- **80°F to 45°F in 10 hours**

Natural sources of nitrite and ascorbate may be used per FSIS Directive 7120.1.

Appendix B- Option 3 Review Question

If an establishment is using Appendix B-Option 3 to cool their cured product, what is the total cooling time?

- 10 hours
- 15 hours
- 6.5 hours

Explanation: Because of the addition of cure at a rate of at least 100 parts per million (ppm) sodium nitrite and 250 ppm of sodium erythorbate or ascorbate the chilling time can be a total of 15 hours - 130°F to 80°F in 5 hours + 80°F to 45°F in 10 hours.

Appendix B-Cured Products Option 4

This is the slowest cooling process provided by Appendix B.

Cool the product temperature from:

- **120°F to 40°F in 20 hours**

Formulated with:

- 40 ppm sodium nitrite and brine concentration 6% **or**
- Maximum water activity (a_w) of 0.92

Appendix B-Option 4 Review Question

If an establishment is using Appendix B-Option 4 for the slow cooling of their cured product, what is the total cooling time?

- 20 hours
- 24 hours
- 15 hours

Explanation: This is the slowest chill time and product chilled under this option **MUST HAVE** a 40% sodium nitrite and brine concentration of 6% **OR** a maximum water activity (Aw) of 0.92.

Appendix B-Cooling Deviations-All Options

- Corrective Actions must be addressed
- Computer modeling program can be used to assess the severity
- Product can be salvaged if model ensures product safety
- Re-cook if model indicates no growth of *C. botulinum* but more than 1-log10 of *C. perfringens*

Lethality and Stabilization

Shelf Stable-Jerky Products

List of Important Guidelines

Cooking Guideline- Revised Appendix A

Stabilization Guideline-Revised Appendix B

Lebanon Bologna Compliance Guidelines Jerky

Compliance Guidelines

Lethality & Stabilization for Jerky Products

- Ready-to-Eat (RTE)
- Dried, shelf-stable

Jerky Processing- 8 Steps

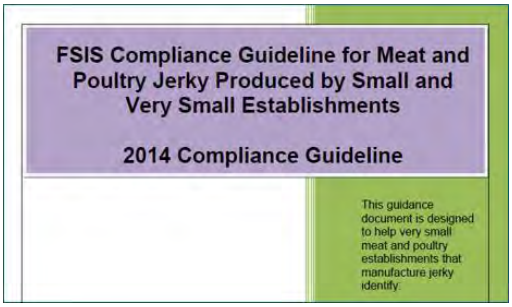
1. Strip preparation
2. Marination
3. Interventions
4. Surface preparation (low heat)
5. **Heating (lethality treatment)**
6. **Drying (stabilization)**
7. Post-drying heat step
8. Handling

Past Problems with Jerky Products

- Produced under low humidity conditions in dry parts of the country, such as New Mexico.
- Heat was absorbed by moisture evaporating from product. Surface dried prior to reaching lethal temperature.
- Heat resistance of bacteria increased with drying.
- Industry relied on MPR (Meat-Protein Ratio) to determine whether product was stabilized-rather than water activity (aw).
- MPR of 0.75:1 is standard to label as "jerky."

Jerky - FSIS Compliance Guideline

The **FSIS Jerky Guideline** describes requirements for lethality treatment (heat and humidity) **prior to drying** to produce safe product.



https://www.fsis.usda.gov/guidelines/2014- 0010

Jerky Production Hazards

Hazards controlled by:

- *Salmonella* - Lethality
- *Listeria monocytogenes* - Lethality and prevention of post-lethality contamination
- *Staphylococcus aureus* - Drying
- *E. coli* O157:H7 (beef) - Lethality

Jerky Process Must Be Supported

- Establishments must decide how to design their process to control hazards.
- Establishments may use FSIS guidelines, published processes, or develop customized processes.
- Important: All critical operational parameters must match the process and are implemented.
- **Process must be validated!!**

Jerky Lethality & Stabilization

Lethality
(Cooking)

Drying
Water Activity (a_w)
Stabilization

Jerky - Lethality and Stabilization Process Steps

Jerky- Lethality Treatment

Meat **cooking (lethality)** process should achieve at least 5.0-log reduction of both *Salmonella* and Shiga-toxin-producing *E. coli* (STEC).

Poultry process should achieve at least 5.0 log reduction of *Salmonella*

The **drying (stabilization)** step results in reduced water activity to prevent the outgrowth of pathogens such as *S. aureus*.

Jerky- Appendix A Humidity Requirements

Inject steam or seal oven for 50% of cooking time or 1 hour (whichever is longer). Cook time/temp of 145°F for 4 minutes or more.

Control relative humidity at 90% for 25% of cooking time or 1 hour (whichever is longer) or entire cooking time if less than 1 hour.

Any other process must have additional supporting documentation of lethality and applies with any time/temperature combination.

Jerky- Impact of Altitude

Establishments located at high elevation may need to increase the amount of moisture in the heating chamber.

Humidity- Seal the Oven & Inject Steam

Establishments may use one of several simple and practical measures suggested by the guidelines to aid in meeting the humidity parameters.

1. **Seal the Oven:** Close the oven dampers to provide closed system & prevent moisture loss.
2. **Add Humidity:** Place one or more shallow, wide pans of hot water in the oven to provide humidity in the system. Injecting steam or a fine water mist in the oven can also add humidity.

Measure & Maintain Humidity

FSIS expects jerky establishments to demonstrate that the method used to maintain humidity is effective.

Establishments can:

- Monitor humidity directly
- Use of wet & dry bulb thermometers
- Demonstrate equipment produces humidity

Wet & Dry Bulb Thermometers

The difference between the wet and dry bulb measurements can be used to determine relative humidity.

Jerky- Control of Hazards- Stabilization (Drying)

After the lethality treatment, the product is dried to meet a water activity level that will stabilize the finished product for food safety purposes.

- Drying/stabilization step results in water activity of .85 or other validated water activity level, to control growth of *S. aureus* in aerobic environment
- In anaerobic environment (vacuum package), water activity can be as high as .91
- Mold controlled with antimicrobial interventions

Review Question - Jerky

What is water activity a measurement of?

- Dryness - amount of water available to bacteria
- Acidity - amount of acid produced by fermentation
- Chilling - whether water is being frozen

Lethality, Stabilization and Multiple Hurdles

Multiple Hurdle Concept

Multiple Hurdles

- Multiple hurdles are combinations of inhibitory factors used by processors to make certain products. Example: Lebanon bologna, a semi-dry fermented sausage.
- These processes must control a complex system of factors and interactions in order to achieve a safe process.

Synergistic Effect

- In dried meat product, environmental conditions are not optimal for bacteria.
- If multiple hurdles are used, they may be more effective than if used alone.
- Example: when pH is lower, the water activity (Aw) that limits growth will be higher.

Multiple Hurdles - Common Factors

- Time
- Temperature
- Water activity (Aw)
- pH
- Nitrite
- Salt
- Chemical inhibitors
- Relative humidity

Multiple Hurdle- Lethality

Most RTE SS products are not specifically addressed with a regulatory performance standard.

- Establishments should identify and support the lethality pathogen reduction targets its multiple hurdles will achieve.
- FSIS recommends lethality of 5.0-log10 reduction of *Salmonella* and 5.0-log10 reduction of STEC for products containing beef.

Industry Processing Guidelines

- 1994- outbreaks of *E. coli* O157:H7 in dry products.
- FSIS / industry meeting resulted in guidelines for processes.

Blue Ribbon Task Force Options

- Several options which ensure a 5-log10 reduction of *E. coli* O157:H7. Other validated process to reduce *E. coli* O157:H7 below 1 cfu/100 gram.
- Processes involve combinations of fermentation temperature, pH, holding times and temps, cooking or heating.
- A heating step per 9 CFR 318.17 or 318.23. Validated heat treatment to achieve 5-log10 reduction of *E. coli* O157:H7.
- Raw meat testing and a 2-log10 lethality treatment.

Degree- Hours- # of hours at a temperature above 60°F before attaining pH of 5.3, multiplied by # of degrees above that temperature.

Meeting degree hours ensures *S. aureus* growth is limited to safe levels but does not support any targeted reduction in *Salmonella*, *E. coli* O157:H7 or *Lm.*

Maximum Temperature	Maximum Degree Hours
<90°F	1200
90°F to 100°F	1000
>100°F	900

Inspection Verification

Hazard Analysis Verification Task to verify that the establishment has:

Supporting documentation and expected level of bacterial pathogen reduction identified.

Critical operational parameters identified and incorporated into process as CCP or pre-requisite program.

Gathered data demonstrates effective implementation.

Key Points

- Key Terms: Lethality, Stabilization & Multiple Hurdle Concept.
- Determining the proper time/temperature options for lethality using Appendix A.
- Understanding the different time/temperature options for chilling product in Appendix B.
- Know when FSIS consider RTE products adulterated.
- What's the difference between a Performance Standard and a Target.
- Understand the role that water activity (a_w) and Humidity play in the Jerky process.

Review Question - Multiple Hurdles

Which is the definition of **multiple hurdles**?

- A step that prevents, eliminates, or reduces hazards to an acceptable level
- Using several process authorities to develop a Hazard Analysis
- Combination of inhibitory factors that work together to prevent bacteria growth

Lethality, Stabilization and Multiple Hurdles

Resource Information

Resources for this topic

Click the hyperlinks below to access additional resource information:

Cooking Guideline - Revised Appendix A

Stabilization Guideline - Revised Appendix B

FSIS Directive 7111.1

Lebanon Bologna Compliance Guidelines Jerky

Compliance Guidelines