

Module 22. Investigation of Canned Food Spoilage Incidents

Thermal Processing for Meat and Poultry Products Training





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Spoilage Definition

SPOILAGE: THE PROCESS OF DECAYING







THERMAL PROCESSING

TRAINING

Spoilage Diagnosis

The primary reasoning behind spoilage diagnosis is to distinguish between post process contamination and insufficient thermal processing.





Spoilage Diagnosis

THERMAL PROCESSING TRAINING

Spoilage diagnosis can only be completed with both inspectional and analytical evidence.



Both are equally important!







Inspectional and Analytical Evidence

- Complementary:
 - Laboratory evidence may assist the CSI in determining the cause of spoilage.
 - Investigative evidence can provide assistance to the laboratory in determining the type of tests to perform.





Analytical Evidence

THERMAL PROCESSING TRAINING

Analytical evidence includes identification of:

- Gross container defects
- Container seam/seal defects
- Product appearance
- Product chemical characteristics
 - pH, Water activity
- Product microbiological test results
 - Identification of organism(s) and their growth characteristics

Normal and abnormal container appearances may help to diagnose type of spoilage.



Normal Looking Container

THERMAL PROCESSING TRAINING Ends remain concave



FLAT

A can with both ends **concave** and remaining in this position when brought down sharply on a hard surface.

Struck on hard surface





Flipper



Struck on hard surface

Can appears to be normal but when brought down sharply on a flat surface one end flips out (convex). End can be pushed back in.



Springer

THERMAL PROCESSING TRAINING Pressure on this end Will cause this end to spring out 9

A can with one end permanently bulged. When pressure is applied to an end the opposite end will spring out. May become soft or hard swell with time.







> OVERFILL - Can that appears similar to a flipper or slight springer but when pressure is applied to the distended end, the other end does not flip out. When shaken, the product does not slosh in the can due to the lack of headspace.





- LACK OF VACUUM Can that appears similar to a slight flipper or end is not concave
- May be caused by canning operations which are not controlled
 - Low Initial Temperature
 - Low Mechanical Vacuum





Soft Swell



Pressure on top or bottom of can causes metal end to move in. May become a hard swell with time.





Hard Swell





Classification of Cans: Buckle

THERMAL PROCESSING TRAINING

> A can that has a raised ridge on one end extending in from a double seam. Buckles are caused by excessive distortion of cans usually in the retort.





Classification of Cans: Paneling

THERMAL PROCESSING TRAINING



Caused by lack of control over the cooling pressure in the retort.





THERMAL PROCESSING TRAINING



CONTAINER TYPES

Leakers

- May be micro leaks detectable only by lab testing.
- May be visible on container or label.





TRAINING

- THERMAL PROCESSING An abnormal container is a container with any signs of swelling or product leakage or any evidence that the contents of the unopened container may be spoiled
 - Defective containers are severe dents near seams, gross seam defects, severe rust, etc.
 - Need to separate to determine % in lot





THERMAL PROCESSING TRAINING

- FSIS Canning Reference Manual
 - FDA, Bacteriological Analytical Manual Chapter – Examination of Container Integrity (Glossary and References
 - Examination of Containers
 - Canned Foods
 - Glass
 - Flexible and Semi-rigid Containers
 - FSIS Microbiological Laboratory Guidebook





- THERMAL PROCESSING TRAINING
 - Often indicates microbiological growth. Note some microbiological growth does not produce gas.
 - May also be caused by production of hydrogen gas through interaction of the food with the container.





Microorganisms of Significance in Canned Food Spoilage

- Microorganisms of public health significance
 - Clostridium botulium
 - Staphylococcus aureus
- Other Bacteria
 - Coliforms
 - Butyric anaerobes
 - Putrefactive anaerobes
- Yeast







Types of Spoilage

- THERMAL PROCESSING TRAINING
 - Incipient
 - Underprocessing
 - Thermophilic
 - Post-Process (e.g., leaker spoilage)
 - Chemical
 - Mishandling





SPOILAGE DIAGNOSIS Definitions

THERMAL PROCESSING TRAINING

LEAKER SPOILAGE:

- Spoilage caused by lack of hermetic seal.
- Product is spoiled, contains mixed microflora and/or has improperly formed seams. 'Pure' cultures may also be found.





INING

Incipient Spoilage Definition/Characteristics

MAL PROCESSING **INCIPIENT SPOILAGE:**

- Spoilage of canned foods or ingredients used in canned foods before thermal processing.
- Cans may be buckled or appear swollen
- Microorganisms noted during microscopic exam appear lysed or granular (non-viable)
- pH may be changed from normal (lower)
- Headspace gas differs from normal
- Low or no vacuum
- Subculture reveals NO viable microorganisms
- Off odor

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Incipient Spoilage

- THERMAL PROCESSING TRAINING
 - Incipient Spoilage can lead to other problems
 - Can buckling in the retort can cause leakage
 - Off flavors or odors can lead to consumer complaints
 - Heat penetration can be adversely affected
 - Product can be considered adulterated and will have to be destroyed





- THERMAL PROCESSING TRAINING
 - Spoilage of ingredients or raw materials before or after receipt by the cannery
 - Excessive hold times between seaming and retorting (FSIS regulations limit hold time to 2 hours)
 - High hold temperatures
 - Holding hot blanched product
 - Operations downtime





Enterotoxin Formation

- THERMAL PROCESSING TRAINING
 - Staphylococcus growth before processing may lead to enterotoxin formation
 - There is no 'apparent spoilage' but the enterotoxin survives the thermal process





- THERMAL PROCESSING TRAINING
 - Spoilage caused by a failure to apply enough heat to a food to ensure destruction of microorganisms capable of growing at normal conditions of distribution and storage





MAL PROCESSING

TRAINING

Commercial Sterility

 Condition achieved by the application of heat to *destroy* microorganisms capable of reproducing in the food under normal nonrefrigerated conditions of storage and distribution, and viable microorganisms (including spores) of public health significance.





MAL PROCESSING

TRAINING

- By the control of water activity <u>and</u> the application of heat which renders the food free of microorganisms capable of reproducing in the food under normal non-refrigerated conditions of storage and distribution.
- FSIS has similar definition for Shelf Stable and Shelf Stability.





SPOILAGE DIAGNOSIS Definitions

THERMAL PROCESSING TRAINING

UNDERPROCESSING:

- A process <u>less than</u> intended
 - Product is still commercially sterile
- A process <u>less than</u> commercially sterile
 - Spoilage organisms may grow but no health hazard
- A process <u>less than</u> minimum public health
 - Concern is Clostridium botulinum





- THERMAL PROCESSING TRAINING
 - Equipment failure
 - Inadequate or improper product formulation or filling procedures
 - Inadequate design and/or delivery of the thermal process
 - HUMAN ERROR





Under Processing: Causes

- Failure to adhere to established critical factors
 - Process time and temperature
 - Initial temperature
 - Fill weights
 - Viscosity/Consistency
 - Excessive fines product style
 - Headspace
 - Formulation changes (starches)
 - Improper rehydration of dry ingredients



Comparison of Filler Methods





- Swollen cans (not always immediate)
- Sporeforming rods with or without spores
- Usually 'pure' cultures
- Containers may be toxic
- Putrid odor





Gross Under-processing

- Mixed flora
- High number of swells





- Deviations in processing records
- Formulation changes
- Employee issues
- Line stoppage/down time
- Problems with automatic controllers such as fill weight
- Gross insanitation
- Contaminated raw materials




Causes:

- Container failure due to poor handling
- Defects, improperly formed seams/seals
- Cooling water contamination
- Loss of sterility in aseptic systems



Causes of Leakage:

- Container abuse (rough handling)
- Improper chlorination of cooling water
- Improper cooling or handling of hot cans
- Improper can manufacture
- Insanitary can conveyors
- Product in can seam or sealing surface
- Mishandling (wet rags around seams)





Causes of Leakage:

- Misadjusted die coders
- Improper seamer adjustment
- Incipient spoilage causing weak seams
- Rough handling during shipment and at retail



THERMAL PROCESSING

TRAINING

Post-Processing Contamination

- ANY microorganism can be involved with leaker spoilage.
 - Need to know organism and growth characteristics to assist in investigation.





Critical Points in Determining Cause(s):

- Incoming container examination
- Relate container damage to plant practices
- Container handling practices
- Line maintenance (no protrusions)
- Plant sanitation practices (lines and conveyors)
- Closure record reviews
- Interviews with plant employees
- Microorganism subculture results



- THERMAL PROCESSING TRAINING
 - Growth in canned foods by spore forming microorganisms capable of germination and outgrowth at elevated temperatures (120 -170°F).
 - Processes designed to provide commercial sterility do not destroy thermopiles.
 - Thermophilic sporeformers are not of public health significance.
 - Thermophiles do not grow at normal conditions of distribution and storage.





Causes:

- Improper cooling of retorted product (104°F or below)
- Stacking or casing improperly cooled product
- Storage at elevated temperatures
- High spore loads in sugar, starch, etc.
- In-plant sanitation problems
- Failure to properly maintain blanchers





Types:

- Flat sour (B. stearothermophilus)
- Thermophilic anaerobes (C. thermosaccharolyticum)
- Sulfide stinker (Desulfotomaculum nigrificans)
- Aciduric thermophiles (*B. coagulans*)





Thermophilic Spoilage

THERMAL PROCESSING TRAINING

Prevention:

- Set standards for raw materials (sugar, starches, tapioca, spices)
- Cool retorted containers properly
- Maintain warehouse storage at cool temperatures
- Do not stack warm or hot containers
- Do not store loaded trucks in direct sunlight
- Maintain good plant sanitation
- Clean and sanitize blanchers
- Maintain blanchers and brines above 160°F





Chemical Spoilage

THERMAL PROCESSING TRAINING

Chemical Spoilage - Spoilage of canned food due to non-microbial causes

Types:

- Hydrogen swells
- Non-enzymatic browning
- Enzymatic spoilage





Chemical Spoilage

- THERMAL PROCESSING TRAINING
 - It is not a major problem with low-acid canned foods
 - Normally due to product and container interaction such as with low pH foods or products containing nitrite







- Types of mishandling:
- Overfills
- Freezing of cans
- Under filled
- Mechanical production errors





THERMAL PROCESSING TRAINING

Abnormal Containers Found at Official Establishments

 When abnormal containers are detected by the establishment during incubation or by other means prior to shipment for the establishment, the establishment must inform the CSI of the finding.



IHERMAL PROCESSING IRAINING

If microbial contamination is addressed in HACCP plan or the establishment uses an alternative written procedure to handle abnormal containers, CSIs are to:

- Verify establishment has adequate procedures in place to control and prevent shipment of affected product.
 - Retain the affected product if the establishment does not have adequate procedures to control the affected product



THERMAL PROCESSING TRAINING

CSIs are to:

- Verify the establishment takes action to determine the cause of the abnormal containers.
- Request incubation records, microbial testing results from sample submitted to its laboratory, and other data that demonstrates food safety.
- Verify the establishment disposes of the affected containers in the suspect lot(s).





THERMAL PROCESSING TRAINING

CSIs are to:

- Verify the method of disposing of abnormal containers in the plan or procedure is fully implemented.
- Verify completion of product disposition and release control of normal appearing containers, if product was retained.





THERMAL PROCESSING TRAINING

When microbial contamination *is not* addressed in a HACCP plan and the establishment *does not* have an alternative written procedure for handling abnormal containers, CSIs are to:

- Retain the abnormal containers and the product lot with abnormal containers pending FSIS laboratory analysis
 - A minimum of 2 hours of continuous production must be retained. There is no maximum.





IHERMAL PROCESSING IRAINING

CSIs are to:

- Perform physical examination of the containers in the lot(s) using the criteria in FSIS Directive 7520.2, Procedures for Condition of Canned Product Container Examination, to determine *number* of abnormal containers/containers with defects.
 - Springers, flippers, soft and hard swells, leakers, no vacuum, and defects such as vees, droops, and deadheads





THERMAL PROCESSING TRAINING

CSIs are to:

- Contact the FSIS Western Laboratory by phone at 510-982-4957
 - Both abnormal and normal containers are submitted for analysis according to the lab's instructions





THERMAL PROCESSING TRAINING

CSIs are to:

 Inform establishment management that it needs to place all abnormal containers under refrigeration to prevent rupture and to preserve their contents and not to freeze abnormal container





MAL PROCESSING

TRAINING

No HACCP Plan/Written Procedure For Handling Abnormal Containers

When *no* obvious defects (droops, vees, deadheads, channel leakers, or incomplete seals) appear on abnormal containers CSIs should:

- Review all processing records for the lot to determine if a process deviation occurred
 - Thermal (retort) operator's log
 - Time/temperature recording chart
 - Critical factor records
 - Formulation records





IHERMAL PROCESSING IRAINING

When *no* obvious defects (droops, vees, deadheads, channel leakers, or incomplete seals) appear on abnormal containers, CSIs should:

- Review additional records
 - Thermal processing system maintenance
 - MIG accuracy records
 - Incubation records for the lot (if any)
 - Closure integrity records to determine if teardown/physical test results were within the specifications
- Process deviation file



MAL PROCESSING

TRAINING

No HACCP Plan/Written Procedure For Handling Abnormal Containers

When obvious defects (droops, vees, deadheads, channel leakers or incomplete seals) appear on abnormal containers, CSIs should:

- Review closure integrity records to determine if the establishment identified the defect and the corrective action taken (when and how corrective actions were taken)
- When obvious defects are found that may explain the spoilage, lab confirmation is still necessary.



THERMAL PROCESSING TRAINING

CSIs should also:

- Determine the storage temperature for the lot
- Determine if the establishment has experienced any other incidents of spoilage, e.g., are there any consumer complaints?
 - How did the establishment handle them?
 - micro exams, seam teardowns, or record reviews





THERMAL PROCESSING TRAINING

CSIs should also:

- Examine other lots produced before and after to determine if similar defects are present
 - Conduct a warehouse inspection, e.g., look for shipping containers with stains/additional abnormal containers
- "Bracket" dates in which the defects occurred
 - Bracketing the time periods in which defects were found may allow FSIS to take regulatory action against all product produced during that time period





- CSIs are to follow the specific instructions provided by the Western lab from the initial call
 - If the affected product is reprocessed or retained pending disposition by a PA, they still submit samples to the lab.
 - If the establishment decides to destroy the product, no further action is required by the CSI, except verifying the establishment properly documents and disposes of the product.





- THERMAL PROCESSING TRAINING
 - Lab will request both normal and abnormal containers
 - Lab will send an email to the CSI requesting information about the affected product
 - CSIs are to provide all information requested, from both the initial phone call and in the e-mail received from the lab





THERMAL PROCESSING TRAINING

- CSIs are to complete and submit the following original forms with the product samples
 - FSIS Form 10,000-2, Laboratory Report;
 - FSIS Form 10,000-3, Canned Foods--Abnormal Containers; and
 - FSIS Form 7500-1 Canned Food Sample Reporting Form (Note: Not applicable for domestic sample submissions).
 - For import abnormal containers, IPP are to complete the laboratory sample form 8000-21 and the questionnaire in the abnormal container TOI.



Sample Submission to the FSIS Lab

- CSIs send one copy of each form, and any additional information requested to:
 - The DO
 - The PDS canning team
- CSIs retain one copy of each form in the government office file





THERMAL PROCESSING TRAINING

- Sample forms include:
 - Number of containers in the lot
 - Total number of containers examined
 - Product information, e.g., product name container type and code(s) lot breakdown
 - Processing information, e.g., type of retort, process schedule, deviation noted, etc.
 - Storage temperature





THERMAL PROCESSING TRAINING

- Sample forms include:
 - Location where abnormals were found, e.g., incubator, warehouse, in distribution
 - The type and number of each type of container abnormality found
 - Correlate with samples (lab must confirm inspectors observations). Swollen cans can change over time.
 - Possible explanation for abnormal containers





Sample Reporting

- Sample forms include:
 - Location of each type of defect noted
 - Use side seam as a marker or mark 12 o'clock position on container
 - Location in lot where sampled container was taken





THERMAL PROCESSING

TRAINING

Sample Reporting



Container defect location - use side seam as starting mark and locate defects by clock time.





Sample Reporting

THERMAL PROCESSING TRAINING

T	2*	4	6
U	1	2*	_
P	1	5.	5

Pallet # 1

	1	3*	5
F R	7	9	11
O N	13	15	17
Τ	19	21	23
)	25	27	29

Lot consists of 8640 16 oz cans of beef stew in 360 cases stacked on 12 pallets. Each pallet holds 30 cases (3 across x 2 deep x 5 high). Each case contains 24 cans (4 across x 3 deep x 2 high). Swollen containers were found in the cases indicated with an * in the diagram. These cases would have been packed at the beginning and at the end of production on 8/12/2015.



THERMAL PROCESSING TRAINING

- Sample location:
 - Sample 1 soft swell collected from lot #, pallet 1, case 2, container 3
 - Sample 2 hard swell collected from lot #, pallet 1, case 3, container 19
 - Sample 3 normal container collected from lot #, pallet 1, case 11, container 22





THERMAL PROCESSING TRAINING

- Sample location (continued)
 - Sample 4 sharp dent on the seam at 3:00 pm on coded end of can from lot #, pallet 1, case 15, container 8
 - Description would continue for all samples
 - Describe pallet/case/container numbering system on sample form




- Lab completes its analysis of abnormal containers submitted
- Forwards the findings to PDS
- PDS reviews lab findings and makes disposition recommendation to DO
- DO makes final disposition ruling on affected product and notifies IPP





- Analytical results
- Number of spoiled containers
- Age of the product
- Location of the spoilage
- History of processing records
- Determine cause of spoilage and hazard to public health





- Regulatory
 - Protect public health
 - Basis for regulatory action
- Industry
 - Protect public health
 - Ensure product wholesomeness
 - Reputation
 - Identify source of problems
 - Economic good sense





Affected Lot Disposition

- THERMAL PROCESSING TRAINING
 - Under-processing: below public health cook
 - Reprocess or destroy
 - Process less than commercially sterile above minimum health
 - Incubate and sort, determine pH





Affected Lot Disposition

- THERMAL PROCESSING TRAINING
 - Post-processing contamination; non-health hazard
 - Sort out swells/defects
 - Dud detection (sort out cans with little or no vacuum)



Questions

Questions?

