Chapter 12

HACCP IN COOKED MEAT OPERATIONS

The Science of Poultry and Meat Processing

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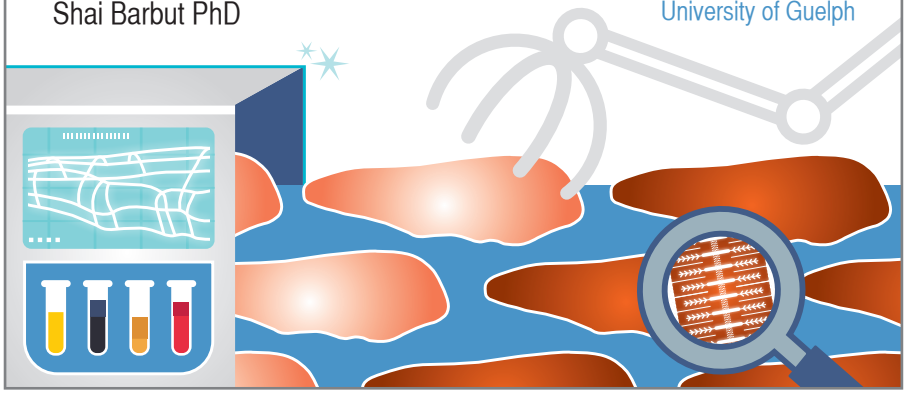

Chapters

* Topics focussing on poultry. Rest of the chapters are related to both red meat and poultry.

Preface

The aim of The Science of Poultry and Meat Processing book is to provide students and industry personnel with a comprehensive view of the modernized primary poultry meat industry and further processing of both red meat and poultry. An emphasis is placed on basic concepts as well as recent advancements such as automation (e.g. increasing poultry line speed from 3,000 to 13,000 birds per hour over the last 40 years) and food safety (e.g. HACCP in primary and the further processing areas). The book also includes chapters explaining basic muscle biology, protein gelation, heat and mass transfer, microbiology, as well as meat colour and texture to help the reader understand the underlying scientific concepts of meat processing. The Science of Poultry and Meat Processing book is based on over two decades of university teaching experiences, and is designed to be used as a course textbook by students, as well as a resource for professionals working in the food industry. The book is available online, at no cost, to any interested learner. Using this format has also allowed me to include many colour pictures, illustrations and graphs to help the reader.

The book is dedicated to my past and current students who have inspired me to learn more and conduct challenging research projects. I see this as an opportunity to give back to the field that I have received so much from as a student and as a faculty member. Looking back, I have learned a great deal from my MSc and PhD advisor, Dr. A. Maurer, who was the student of Dr. R. Baker - the father of poultry processing in North America. I would also like to thank Dr. H. Swatland with whom I worked for almost 20 years, for the many challenging scientific discussions.

Writing The Science of Poultry and Meat Processing book was a long process, which also included having all chapters peer reviewed. I appreciate the help of my colleagues, but I still take responsibility for any inaccuracy in the book. If you have comments or **suggestions,** I would appreciate hearing from you (sbarbut@uoguelph.ca), as I am planning to revise and update a few chapters on a yearly basis.

I would like to thank the many people who have helped me during the writing process. To Deb Drake who entered all of the material for the book, to Mary Anne Smith who assisted in editing, and to ArtWorks Media for the design and desktop publishing of the book. I greatly appreciate the help of my colleagues who reviewed chapters and provided useful discussions. They include Mark B., Ori B., Sarge B., Gregoy B., Joseph C., Mike D., Hans G., Theo H., Melvin H., Myra H., Walter K., Roland K., Anneke L., Massimo M., Johan M., Erik P., Robert R., Uwe T., Rachel T., Jos V., Keith W., and Richard Z. I would also like to thank my family for their love and support during the entire process.

About the Author

Shai Barbut is a professor in the Department of Food Science at the University of Guelph in Ontario, Canada. He received his MSc and PhD at the University of Wisconsin in meat science and food science. He specializes in primary and further processing of poultry and red meat. His research focuses on factors affecting the quality of meat, as well as protein gelation with an emphasis on structure / function relationships, rheological properties and food safety aspects. He has published over two hundred peer reviewed research papers and is the author of the Poultry Products Processing – An Industry Guide textbook. He is a fellow of the Institute of Food Technologists and has received awards from the Meat Science Association, Poultry Science Association, and the Canadian Institute of Food Science and Technology. He is involved in a number of government committees as well as academic and industrial research projects.

Library and Archives Canada Cataloguing in Publication

Barbut, Shai, author

The science of poultry and meat processing / Shai Barbut, PhD.

Includes bibliographical references and index.

Issued in print and electronic formats.

ISBN 978-0-88955-625-6 (bound).

ISBN 978-0-88955-626-3 (pdf).

1. Poultry--Processing. 2. Meat industry and trade. I. Title.

TS1968.B37 2016 664'.93

C2015-903906-1 C2015-903907-X

12

HACCP IN COOKED MEAT OPERATIONS

12.1 Cooked Product – Generic HACCP Model for Cooked Meat

A large portion of the further processed meat products in the marketplace are sold as fully cooked products. Examples include luncheon meats (e.g., bologna, mortadella), whole muscle meats (e.g., oven roasted chicken/turkey, ham) and fermented products (e.g., pepperoni, summer sausage). This chapter describes a generic HACCP model that was developed for cooked ham using either whole muscle turkey/pork leg meat. The model is used to illustrate production steps common to cooked products and it also discusses potential critical control points (CCPs) and limits that could be set to control hazards. The generic model described here was developed by the Canadian Food Inspection Agency (CFIA, 1998). However, it can also be used as an example for various types of other cooked meat products. An introduction to HACCP and its seven principles has been provided in Chapter 6. The model described in this chapter has many similarities to the USDA (1999) model for cured, cooked products, which includes the 'ready-to-eat' (RTE) category of products that do not require heating prior to consumption by the consumer. However, some are heated to enhance product's acceptability (e.g., frankfurter). The products are cured, which means that they contain different salts (e.g., sodium chloride, sodium phosphate, sodium nitrite) that can also play a role in preserving the product (see Chapter 15). After cooking, proper refrigeration or freezing is commonly used to maintain the safety of the RTE product and to prolong the shelf life. A description of the product is available in Table 12.1.1, which is part of the HACCP documentation.

Table 12.1.1 Product description – cooked sliced, ham (e.g., turkey, pork). Modified from CFIA (1998).

Product name	**Cooked, sliced turkey ham**
Important product characteristics (pH, aw)	salt - not less than X%; nitrite - X ppm
Use of product	sliced, ready-to-eat
Packaging	vacuum packaged
Shelf life	X days (e.g., 50 days) after slicing when kept at ≤ 4°C
Distribution	retail, food service
Labeling instructions	best before date, keep refrigerated
Special distribution control	under refrigeration or frozen

12.2 Process Steps

The process flow diagram is presented in Fig. 12.2.1. In addition, see Chapter 10 for a detailed description of the processing steps involved in preparing a cooked product and the equipment used. The process starts with receiving the meat and all the non-meat ingredients. This is also the first control point for biological, chemical, and physical hazards (see Table 12.2.1). The biological hazards mainly include microorganisms in the raw meat (e.g., *Salmonella*) or bacteria that have been transferred from people handling the meat at the plant (e.g., *Staphylococcus*). Of major concern is also the introduction of pathogens to the cooked product prior to packaging (i.e., cross contamination). Table 12.2.1 indicates that CCP-6B and CCP-7B (the cooking and chilling steps, respectively) are two potential control points for this kind of a hazard. Overall, the cooking step is designed to kill most (if not all) of the non-spore forming bacteria (e.g., *Listeria*), and therefore post-cooking contamination can be a major safety issue as is also indicated by CCP-8B, which refers to slicing the fully cooked product (see also discussions on *E. coli* and *Listeria* in Chapter 15).

Chemical hazards in the incoming raw meat may include antibiotics, pesticides and other drug residues that are not permitted by law. Therefore, the receiving point is designated as CCP-1, meaning that the raw materials must be checked. In some cases the processor will require a Letter of Guarantee from the raw meat ingredient supplier to certify that there are no antibiotics or pesticides in the raw ingredients. Besides being illegal, these ingredients can also interfere

with processing procedures such as fermentation (e.g., presence of low levels of antibiotic will prevent the growth of lactic acid bacteria and result in a significant economic loss).

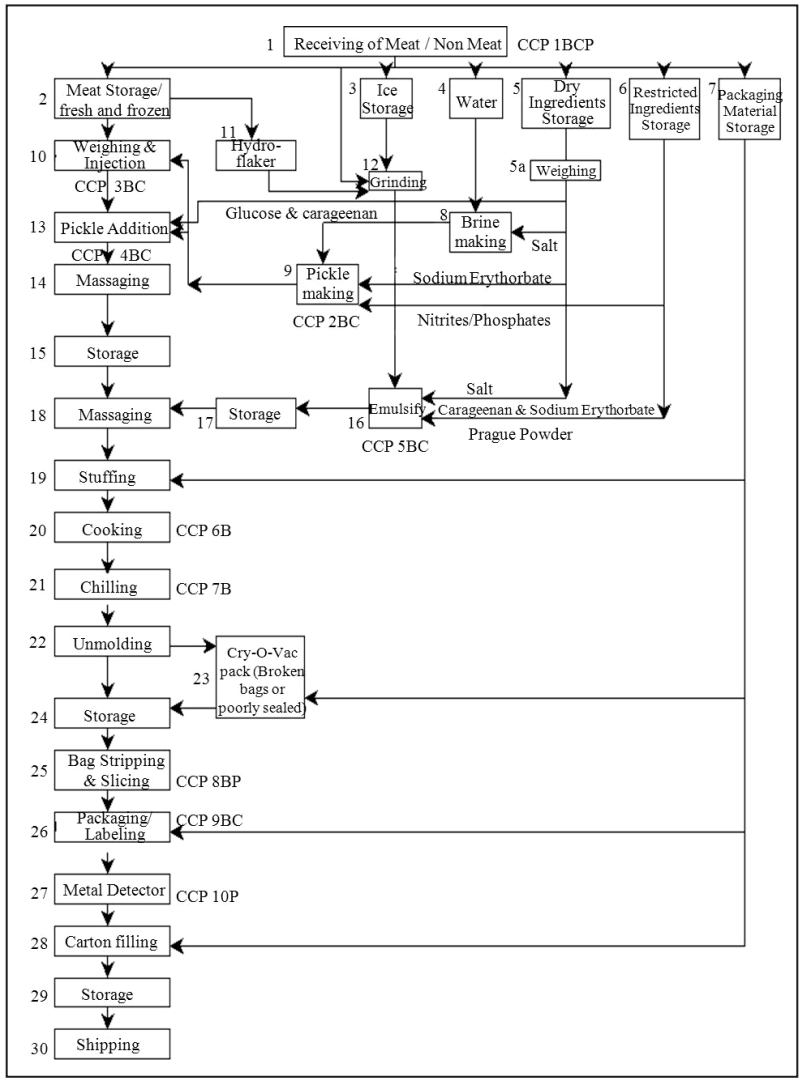

Figure 12.2.1 A flow diagram illustrating the steps involved in the production of sliced cooked ham (e.g., turkey, pork), including suggested critical control points (CCP) for biological (B), chemical (C) and physical (P) hazards. From CFIA (1998).

Table 12.2.1 List of biological (B), chemical (C), and physical (P) hazards and critical control points (CCP) related to incoming materials and processing steps for cooked, sliced ham (e.g., turkey, pork). From CFIA (1998).

Identified Biological Hazards (Bacteria, Parasites, Viruses, etc.)	**Controlled at**
Incoming Materials	
Raw Meat (as received) & Ground Trims – Non-spore forming pathogenic bacteria – *Listeria monocytogenes, Staphylococcus aureus, Yersinia sp., Campylobacter sp., Salmonella sp., E. coli,* etc. – Spore forming pathogenic bacteria – *C. perfringens, C. botulinum,* etc.	CCP-6B CCP-7B
Water (as received) – *Coliforms, faecal coliforms*	Prerequisite programs (Water quality program)
Ice (as received) – *Coliforms, faecal coliforms*	CCP-1BCP
Process Steps:	
#1 Receiving of non-compliant material – Fresh Meat & Non Meat Ingredients: Bacterial (Pathogen) growth due to time/temperature abuse and cross contamination	CCP-1BCP
#2 Meat Storage – Bacterial growth due to time/temperature abuse	Prerequisite programs (Transport & Storage)
#7 Storage of Packaging material – Bacterial pathogens growth due to environment (rodent, insects, etc.)	Prerequisite programs (Sanitation and pest control)
#9 Pickle Making – Bacterial pathogens growth in finished product due to insufficient amount of Nitrite in pickle formulation	CCP 2BC
#10 Weighing and Injection – Bacterial pathogens growth in finished product due to too little pickle in product	CCP 3BC
#12 Grinding – Contamination due to poor sanitizing of equipment	Prerequisite programs (Sanitation)
#13 Pickle Addition – Bacterial pathogens growth due to insufficient amount of pickle	CCP-4BC
#15 Storage – Bacterial pathogens growth due to time/temperature abuse	Prerequisite programs (Transport & Storage)
#16 Emulsification – Bacterial pathogens growth in finished product due to insufficient addition of Prague powder	CCP-5BC

#16 Emulsification – Bacterial pathogens growth due to time/temperature abuse	Prerequisite programs (Employee Training)
#17 Storage of emulsion – Bacterial pathogens growth due to time/temperature abuse	Prerequisite programs (Transport & Storage)
#19 Stuffing – Bacterial pathogens growth due to time/temperature abuse	Prerequisite programs (Employee Training)
#20 Cooking – Survival of pathogens due to inadequate temperature or cooking time	CCP-6B
#21 Chilling – Spores of *C. perfringens* sporulation & growth due to inadequate chilling rate	CCP-7B
#22 Unmolding – Bacterial contamination from poor handling of bags	Prerequisite programs (Employee Training)
#23 Vacuum packing (broken poorly sealed bags) – Cross contamination with pathogens (e.g., *Salmonella sp., L. monocytogenes, S. aureus*, etc.) by employee inadequate handling/unclean equipment	Prerequisite programs (Employee Training)
#24 Storage – Bacterial pathogens growth due to time/temperature abuse	Prerequisite programs (Transport & Storage)
#25 Bag stripping & slicing – Cross contamination with pathogens (e.g., *Salmonella sp., L. monocytogenes, S. aureus*, etc.) by employee inadequate handling/unclean equipment	CCP-8B
#26 Packaging/Labeling – Cross contamination with pathogens (e.g., *Salmonella sp., L. monocytogenes, S. aureus*, etc.) by employee inadequate handling/unclean equipment	Prerequisite programs (Employee Training)
#26 Packaging/Labeling – Bacterial pathogens growth due to improper coding (best before)	CCP-9BC
#29 Storage – Bacterial pathogens growth due to time/temperature abuse	Prerequisite programs (Transportation & Storage)
Identified Chemical Hazards	**Controlled at**
Incoming Materials	
Raw meat (as received) & Ground trims – Antibiotics, Pesticides, Drug residues	
Water (as received) – Chemical residues in incoming Water	Prerequisite programs (Water quality program)
Ice (as received) – Chemical residues in incoming Ice	N/A
Packaging material (as received) – Chemical migration of non-food grade packaging material, inaccurate labeling by supplier	CCP-1BCP

Process Steps:	
#1 Receiving – Receiving of non-compliant material (see above)	CCP-1BCP
#9 Pickle Making – Excess nitrite in the pickle	CCP-2BC
#10 Weighing & Injection – Excess nitrite in the pickled product (over pumping)	CCP-3BC
#13 Pickle addition – Toxicity: excess of nitrite (over addition)	CCP-4BC
#16 Emulsify – Excess nitrite added as Prague powder	CCP-5BC
#26 Packaging/Labeling – (Some ingredients not declared on label). Allergic reactions due to wrongly labeled product	CCP-9BC
Identified Physical Hazards	**Controlled at**
Incoming Materials	
Foreign material of non-metallic origin in Meat	CCP-1BCP
Foreign material of non-metallic origin in Ice	CCP-1BCP
Foreign material of non-metallic origin in Salt	N/A
Metallic particles in Meat	CCP-10P
Metallic particles in Ice	CCP-10P
Metallic particles in Salt	N/A
Packaging material contamination with foreign material	CCP-1BCP
Process Steps:	
#1 Receiving of meat and non-meat products – Contamination with foreign material (see above)	CCP-10P
#5 Storage/weighing of Dry Ingredients – Contamination with foreign material	Prerequisite programs (Transport & Storage)
#6 Storage of Restricted Ingredients – Contamination with foreign material	Prerequisite programs (Transport & Storage)
#7 Storage of packaging Material – Contamination with wood, metal, etc.	Prerequisite programs (Transport & Storage)
#8 Brine Making – Foreign material falling into the brine	Prerequisite programs (Premise Control, Equipment Maintenance)
#9 Pickle Making – Foreign material falling into the pickle solution	Prerequisite programs (Premise Control, Equipment Maintenance)
#10 Weighing and Injection – Broken needles	CCP-10P
#11 Hydroflaking – Metal fragments from damaged inadequately maintained equipment	Prerequisite programs CCP-10P

#12 Grinding – Non-metallic foreign material	Prerequisite programs (Premise Control, Equipment Maintenance)
#12 Grinding – Metal fragments from damaged inadequately maintained equipment	Prerequisite programs (Equipment maintenance) CCP-10P
#14 Massage – Metal fragments from damaged inadequately maintained equipment	Prerequisite programs (Equipment maintenance) CCP-10P
#15 Storage – Foreign material falling in product	Prerequisite programs (Premise Control, Equipment Maintenance)
#16 Emulsify – Metal fragments from damaged inadequately maintained equipment	Prerequisite programs (Equipment maintenance) CCP-10P
#18 Massaging – Metal fragments from damaged inadequately maintained equipment	Prerequisite programs (Equipment maintenance) CCP-10P
#19 Stuffing – Metal fragments from damaged inadequately maintained equipment	Prerequisite programs (Equipment maintenance) CCP-10P
#19 Stuffing – Non metal foreign material contamination	Prerequisite programs (Premise Control, Equipment Maintenance)
#27 Metal Detector – Malfunction of the metal detector ferrous metal and aluminum not properly detected	CCP-10P
Identified Hazards	**Indicate the way the Hazard could be Addressed (Cooking Instructions, Public Education, Use Before Date, etc.)**
Incoming Materials	
Chemical – Antibiotics, Drug residues, Pesticides in incoming meat products	Producer education and practices/ proper withdrawal periods observed

Physical hazards in the incoming meat (Table 12.2.1) may include metallic and non-metallic substances (e.g., glass, wood, plastic) that might accidentally fall into the product and/or arrive already in the product (e.g., broken injection needle). This critical step (CCP-1) should be designed to eliminate foreign particles by sampling on raw materials to verify compliance. In addition, some companies are using supplier audit programs where they go visit and inspect facilities. If the number

of complaints (related to foreign objects or other safety/quality issues) increases, more audits will be performed. If no improvement is seen, the supplier might be terminated. At the food processing plant, raw material sampling is performed by equipment such as a metal detector, x-ray (see photo in Chapter 9), or simple visual inspection to identify and then remove any potential problems. Because metal parts (e.g., screws) can fall into the product during processing, a metal detector is also positioned at the end of the processing line to check the final products before shipping (Fig. 12.2.1). However, if there is a known problem of meat arriving with metal particles a metal detector should be placed at the raw material receiving point. Spice suppliers, for example, check all their raw materials (e.g., using metal detectors, sieving) prior to shipping goods to the meat processing plant and are also usually required to provide a Letter of Guarantee.

Table 12.2.2 shows a detailed step-by-step design of a HACCP plan to control the various identified hazards. The table provides information about critical limits, monitoring procedures, deviations, verifications, and record keeping. An introduction to the different steps can be found in Chapter 6.

Table 12.2.3 is an example of a HACCP record keeping sheet for monitoring the showering and chilling of the final cooked product. It is essential that the process be monitored on a continuous basis. That way, problems are flagged as soon as possible and the employee responsible can execute the pre-determined corrective actions and/or reprocessing steps. The rigid process and pre-determined corrective actions take away any employee guesswork, allow the HACCP plans to evolve, and also demonstrate to the inspection agency that consistent corrective actions are taken. Each deviation, its date, and its corrective actions must be available to inspectors. It is usually mandatory to keep records for several years (e.g., 5 years). This tool also helps plant management to focus on sensitive areas and use the concept of an improvement loop to continuously enhance food safety.

There are other documents that can be used to help the processor in designing and/or improving the generic model (i.e., as indicated in Chapter 6, the generic model is intended to be used as a starting point for a specific plant). An example of a useful document is the USDA Compliance Guidelines for Meeting Lethality Performance Standards for Cooked Ready-To-Eat (RTE) Meat and Poultry Products. In it, the USDA is presenting a lethality model for cooked, sliced meat that illustrates how processors can ensure that a specified minimum destructive temperature is achieved and maintained long enough to inactivate certain pathogens.

Table 12.2.2 Examples of details about some suggested critical control points (CCP) provided in the HACCP Generic Model for cooked sliced, ham (e.g., turkey, pork). From CFIA (1998).

Process Steps	CPP/ Hazard Number	Hazard Description	Critical Limits	Monitoring Procedures	Deviation Procedures	Verification Procedures	HACCP Records
#1 Receiving	CCP-1BPC	Presence of pathogenic bacteria. Bacterial pathogen growth due to time/ temperature abuse and cross contamination.	Normal colour and odour. Contractual specifications for meat products. Maximum temperature of 4° C at the center and surface of meat products. Slaughter/packaging date (max "X" days) for fresh meat. Contractual specifications for hygienic slaughter & boning/handling procedures + transport temperatures for meat product.	Receiver to check lots are covered by contractual specifications for each lot received. Receiver to take temperature of every lot of meat. Check slaughter packaging date. Visually examine for carton damage. Organoleptic examination of product.	Receiver is to place non compliant shipment on hold & inform foreperson and supplier. Product is to be returned or QC test/ decision.	QC to verify log book & procedures once a week. QC check temperature & collect sample for micro verification once a week. QC audit supplier plants.	Receiver's log book. QC records temperature book. Microlab analysis records.
		Bone chips in boneless meat. Extraneous material, metal, wood.	No foreign material 2mm or larger.	Receiver checks that contractual specifications exist for each incoming material. Boneless turkey inspection program at supplier level. Receiver checks product if cartons are damaged.	Hold shipment & inform foreperson & Supplier.	QC to verify log book once per week. QC to perform boneless reinspection every "X" shipment. Product Random sample.	

Process Steps	CPP/ Hazard Number	Hazard Description	Critical Limits	Monitoring Procedures	Deviation Procedures	Verification Procedures	HACCP Records
#1 Receiving	CCP-1BPC	Packaging material non food grade.	Contractual specifications "Approved" material only.	Receiver to allow unloading only if from approved Supplier/ Material.	Do not allow unloading. Notify QC. QC holds products, requests proof of approval or returns product.		
#9 Pickle making	CCP-2BC	Too little/too much Sodium nitrite ($NaNO_2$) in the pickle mixture.	"Y" ppm for each formulation (volumetric measuring devices within lab. tolerances).	Inventory control sheet by pickle maker. Daily check sheet for each recipe. Test strips used by pickle maker on each batch to indicate presence of nitrite.	Pickle maker to notify foreperson, hold pickle. Foreperson to hold product already pumped & notify QC.	QC to test pickle batches 2×/week with test strips. Review of records 1×/week.	Pickle room check sheet Lab reports.
#10 Weighing & Injection	CCP-3BC	Too little $NaNO_2$ in the product. Excess of $NaNO_2$ in the pickled product (over pump).	Weight after pumping = weight before pumping plus "X"%.	Operator records green & pumped wt. on control sheets and ensures that % of pumping is respected.	Recalibrates injection machine, hold product. Inform QC of over pumped product.	Foreman audits control sheets 2×/ day and verify % of pumping. QC verifies control sheet weekly (green wt. vs pumped wt.) and verify % of pumping.	Injection control records control sheet.

Process Steps	CPP/ Hazard Number	Hazard Description	Critical Limits	Monitoring Procedures	Deviation Procedures	Verification Procedures	HACCP Records
#13 Pickle Addition	CCP-4BC	Under pump, too little $NaNO_2$ in the product. Excess of $NaNO_2$/over pump.	Pump at "X"%.	Batch weight to equal green weight + "X"%. Finished wt. to = formula wt. for each batch.	Add more pickle, standard operating procedure is to purposely under pump. Pickle injector operator is responsible for topping up each batch to the correct wt. Adjust pickle injector.	Control sheet. Daily scale checks with check weights. Foreperson audits control sheets 2×/ day. QC verifies control sheets weekly (green wt. vs pumped wt.).	Control sheet. Scale check sheet.
#16 Emulsify	CCP-5BC	Too little or excess of $NaNO_2$ in the emulsion.	Add correct wt. of Prague powder as per formula.	Batch control sheets. Formulation signed by the operator.	Hold, contact foreperson and QC. QC to reformulate.	Random lab analysis performed by QC 2× per week. Foreperson to verify 1x/day.	Batch control sheets. QC lab report.
#20 Cooking	CCP-6B	Survival of pathogens due to inadequate cooking time or temperature.	Cooking house temperature/time cycle functioning. Temperature and time limits "X" hrs & "Y"° C.	Check cooking cycle. Manual temp. check by the operator for every batch, thermograph checked and signed by the operator.	Cook to internal temp. of "Y"° C (extend cooking time as necessary).	Thermograph charts reviewed weekly by QC.	Thermograph charts kept on file by QC.

Process Steps	CPP/ Hazard Number	Hazard Description	Critical Limits	Monitoring Procedures	Deviation Procedures	Verification Procedures	HACCP Records
#21 Chilling	CCP-7B	Growth of *C. perfringens.*	Chill to 4° C in 12 hours or less. Chill water temperature cycle as defined in plant chilling process.	Every batch has a manual temperature check by the operator. Shower product to "Y"°C internal temp., chill to 4° C in 12 hours or less. Check chill water temperature.	Operator monitors room temperature & records deviations. Temperature control person investigates if there is a deviation & if problem cannot be corrected within 1 hour, he/ she contacts fore-person in charge of production. Product moved to coldest section for chilling.	Records reviewed by QC on a daily basis. Audit monitoring procedures at "X" frequency.	Room temperature records and product internal temperature.
#25 Bag Stripping & Slicing	CCP-8B	Cross contamination of product or improper employee handling practices.	Clean and sanitized gloves. Contact with anything other than the loaves requires hand dipping (sanitizing) prior to resuming bag stripping duties. No tolerance of soiled gloves or hands.	Monitoring by foreperson of employee practices by random inspection 2×/day and record results.	Foreperson will instruct the employee on proper procedure and monitor until the employee's performance is satisfactory. Product trimmed sent for rework.	QC to verify employee handling practices through periodic audits 1×/ week. QC swabs gloves and contact surfaces at least once a week.	Departmental QC check sheets. Swab reports on equipment and gloves.

Process Steps	CPP/ Hazard Number	Hazard Description	Critical Limits	Monitoring Procedures	Deviation Procedures	Verification Procedures	HACCP Records
#26 Packaging	CCP-9BC	Pathogenic bacterial growth due to wrong best before date.	Correct date as determined by shelf life testing.	Designated employee check best before date when checking ingredients listing for each lot.	Foreperson detains defective packages for repackaging. Record each incident.	QC verifies best before date and ingredients listing versus formulation records "X" times/ month.	Departmental QC check sheets.
		Allergies due to incomplete/wrong list of ingredients to the product.	Label to match the product. No tolerance.	Line operator (label installer) will check to ensure correct label is in place at start of each lot and record results.	Designated employee will hold product for repackaging/ relabeling correctly.	Foreperson to randomly check 2×/day and record beginning of each product run. QC reviews departmental check sheet weekly.	Departmental QC check sheets.
#27 Metal Detector	CCP-10P	Metal and aluminum not detected due to detector not functioning or improper calibration.	No metal greater than 2mm in size.	Every package goes through the metal detector. Electrician checks the calibration of the metal detector prior to the start of operations each day and signs the check sheet. Employee checks function of detector by running a test wand through the metal detector 4× per day.	If larger than 2mm in size product is rejected by the metal detector. Notify foreperson & QC. Every "ringer" the lot goes to QC for investigation. Product is held until QC determines cause. Product is retested since last satisfactory test.	QC runs test wand through the metal detector 4x per week. Every "ringer" goes to QC for investigation.	Departmental daily check sheet. Lab contamination report from QC. Contamination file.

Table 12.2.3 HACCP record keeping sheet. An example for monitoring and record keeping of the shower chill for cooked meat products. From CFIA (1988).

Freq.	Foreman	Each Batch	Each Batch	Each Batch	Each Batch	Each Batch	Each Batch	Each Batch	Each Batch		
Freq.	Q.C.	Freq. "X"	Freq. "X"	Freq. "X"	Freq. "X"	Freq. "X"	Freq. "X"	Freq. "X"	Freq. "X"		
Date	Hour	LOT#	State shower time	End shower time	Temperature of product "Y"° C	Chill time in	Chill time out	Final product chill temp. Max 4° C	Total chill time (from start of shower to final chill) Max 12 hrs	Results/Actions	Initials

In 2001, the Food Safety and Inspection Service (FSIS) proposed a rule entitled "Performance Standards for the Production of Processed Meat and Poultry Products'' (66 FR 12590). The proposed regulations included performance standards, *Listeria* testing requirements, and also standards for the destruction of *Trichina* in pork products. The regulations are also applicable to cooked beef, roast beef, chunked and formed roasts, corned beef, and poultry products. The FSIS included compliance guidelines for lethality (Appendix A of the final rule) that describes times and temperatures necessary to achieve a 6.5 log10 or 7.0 log10 reduction of *Salmonella* in meat products (Dawson et al., 2012). These same compliance tables can be used for other RTE meat, such as meat patties. Regulations about cooling times of fully cooked products are also used to eliminate/reduce the risk of microorganisms such as *C. perfringens* growth during the cooling phase.

The proposed regulations also indicated that:

a. Cooked poultry rolls and other cooked poultry products should reach an internal temperature of at least 160 °F prior to being removed from the cooking medium. However, cured and smoked poultry rolls and other cured and smoked poultry should reach an internal temperature of at least 155 °F prior to being removed from the cooking medium. Cooked ready-to-eat product to which heat will be applied incidental to a subsequent processing procedure may be removed from the media for such processing provided that it is immediately fully cooked to 160°F internal temperature.

b. Establishments producing cooked poultry rolls and other cooked poultry products should have sufficient monitoring equipment, including recording devices, to assure that the temperature (accuracy assured within 1 °F) limits of these processes are being met. Note that manual detection should also be performed to verify recorders are working correctly. Data from the recording devices should be made available to FSIS program employees upon request.

The FSIS also included revised time-temperature combinations for cooking RTE poultry (i.e., revised from the previous combinations published for products such as roast beef and pork). The revised material was previously published in a scientific paper (Juneja et al., 2001). The authors developed a formula for predicting time/temperature combinations necessary for achieving a 7 $\log_{10}$ reduction of *Salmonella* in RTE poultry with different fat levels, as well as standard errors for these predictions (see example in Table 12.2.4). The revised times are actually significantly longer than those that were assumed to be effective in the past. A processor can also consult the different alternatives for *Listeria* control issued by FSIS (2014).

Table 12.2.4 Guidelines for time x temperature cooking combinations to achieve a 7 $\log_{10}$ *Salmonella* reduction in poultry products containing 4 or 8% fat. Based on data from Juneja et al. (2001).

fat% = 4					fat% = 8				
Temperature	time for		time for		Temperature	time for		time for	
F	Chicken	unit	Turkey	unit	F	Chicken	unit	Turkey	unit
136	67	min	64.9	min	136	73	min	66.9	min
137	53.2	min	52.8	min	137	58.2	min	54.7	min
138	42.2	min	43	min	138	46.4	min	44.8	min
139	33.6	min	35.1	min	139	37.2	min	36.7	min
140	26.8	min	28.7	min	140	29.8	min	30.2	min
141	21.5	min	23.5	min	141	24	min	24.9	min
142	17.2	min	19.3	min	142	19.4	min	20.5	min
143	13.8	min	15.9	min	143	15.6	min	17	min
144	11.1	min	13	min	144	12.6	min	14	min
145	8.9	min	10.7	min	145	10.2	min	11.5	min
146	7.2	min	8.8	min	146	8.2	min	9.5	min
147	5.7	min	7.2	min	147	6.6	min	7.7	min
148	4.5	min	5.8	min	148	5.2	min	6.3	min
149	3.6	min	4.7	min	149	4.1	min	5	min
150	2.7	min	3.7	min	150	3.1	min	4	min
151	2.1	min	2.9	min	151	2.3	min	3.1	min
152	1.6	min	2.3	min	152	1.7	min	2.3	min
153	1.2	min	1.9	min	153	1.3	min	1.9	min
154	59.1	sec	1.5	min	154	1.1	min	1.5	min
155	46.8	sec	1.2	min	155	50.4	sec	1.3	min
156	37	sec	59.8	sec	156	39.9	sec	1	min
157	29.3	sec	48.5	sec	157	31.6	sec	49.5	sec
158	23.2	sec	39.4	sec	158	25	sec	40.1	sec
159	18.3	sec	32	sec	159	19.8	sec	32.6	sec
160	14.5	sec	26	sec	160	15.6	sec	26.4	sec
161	11.5	sec	21.1	sec	161	12.4	sec	21.5	sec
162	<10.0	sec	17.1	sec	162	9.8	sec	17.4	sec
163	<10.0	sec	13.9	sec	163	<10.0	sec	14.1	sec
164	<10.0	sec	11.3	sec	164	<10.0	sec	11.5	sec
165	<10.0	sec	<10.0	sec	165	<10.0	sec	<10.0	sec

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