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Improving poultry meat safety and sustainability

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Safety management and monitoring in poultry slaughter operations: a United States perspective

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1 Introduction

Poultry processing safety monitoring refers to the practice of regularly checking and evaluating the safety protocols and procedures in place during the processing of poultry products. This monitoring helps ensure that the processing facility complies with food safety regulations and industry best practices. The ultimate goal of safety management and monitoring is to prevent contamination and reduce risks of poultry products while also maintaining worker health and safety.

The safety management and monitoring process is conducted using a systematic approach with both facility-tailored and defined program plans, including Good Manufacturing Practices (GMPs), Sanitation Standard Operating Procedures (SSOPs), and Hazard Analysis and Critical Control Point (HACCP) plans. These plans typically involve conducting regular inspections and audits of the entire poultry processing facility, including verifying food safety protocols, checking the cleanliness and hygienic conditions of processing areas, equipment and utensils, as well as the workers' personal hygiene and

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protective measures. Potential hazards are identified through collecting and analyzing samples of poultry products for microbial, chemical, or physical contaminants to allow corrective actions to be taken promptly. Inspections and audits are conducted by personnel trained in food safety regulations that can accurately assess compliance. Management should establish regular training and education schedules to ensure employee knowledge is current.

By conducting regular safety monitoring, poultry processing facilities can identify and address potential risks and hazards, maintain high hygiene standards, and ensure the safe production of poultry products for consumers.

2 The commercial poultry processing environment

The poultry processing environment poses potential physical, chemical, and biological risks (e.g. bone fragments, residues, and foodborne pathogens) both to employees within the processing plant and downstream to consumers who purchase the products produced in poultry processing facilities. The conversion of muscle to meat typically follows the same general flow (Fig. 1). After birds have been harvested from the farm, they are transported to the processing plant, where they are held before processing. The process of catching, loading, transporting, and unloading birds is known as live haul. The period when birds are kept in a dedicated area before they are processed is known as lairage. When it is time for processing, birds enter the processing plant itself, where they are then stunned before exsanguination. The head is subsequently removed, and birds are scalded with hot water to aid the removal of feathers during picking. Following picking, the feet are removed, and the carcasses are transferred to a new shackle line, opened, and eviscerated to remove the digestive tract and other organs. The carcass is then chilled to reduce the temperature of the meat from approximately 104°F (40°C) at the time of slaughter to below 40°F (4.4°C). After the meat has been cooled to below 40°F, the carcass can be packaged and sold as whole or deboned. Poultry parts (e.g. wings, leg quarters, breast

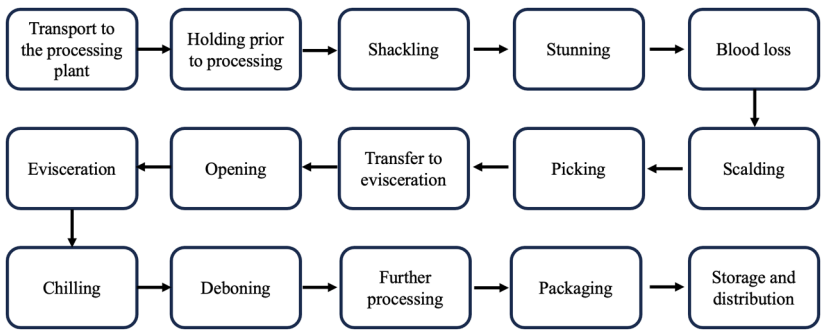

Figure 1 The general flow of a poultry processing facility.

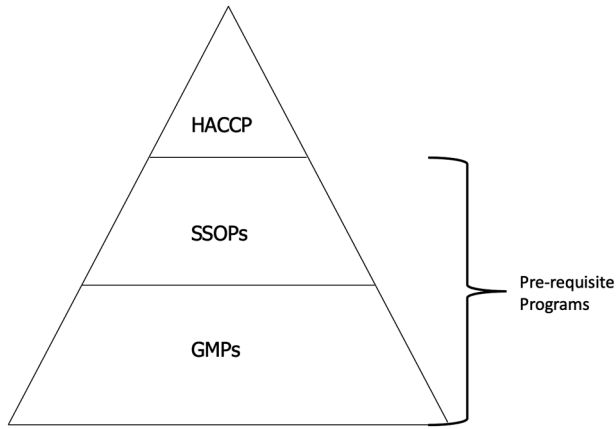

Figure 2 Good Manufacturing Practices (GMPs) and Sanitation Standard Operating Procedures (SSOPs) are the base Prerequisite Programs needed for an effective Hazard Analysis and Critical Control Points (HACCP) plan.

fillets, etc.) can be packaged and sold as Not-Ready-to-Eat or further processed through marination, batter/breading, and cooking processes.

This process, from live bird receiving through the final product, poses multiple risks to personnel and end consumers. Numerous systems which build upon each other have been put into place to mitigate these risks. Pre-requisite programs are the foundational building blocks of HACCP (Fig. 2). Without effective pre-requisite programs, many foodborne hazards in the processing environment would result in foodborne illnesses. Prerequisite programs include GMPs and SSOPs. Although both regulations contain similar language, the implementation is quite different.

GMPs underlie the prerequisite programs for most plants with a broad range of goals that produce an environment conducive to food processing. GMPs typically address extensive issues such as plant layout, pest control, and employee hygiene. SSOPs narrow this focus. SSOPs involve more specific concerns, such as the condition and cleanliness of particular food contact surfaces, actual sanitation procedures, and protection of food from contamination with fuel, pesticides, and other adulterants. USDA-FSIS has mandated the implementation of written SSOPs in HACCP plants.

3 Good manufacturing practices

GMPs are guidelines and principles established to ensure the quality, safety, and consistency of food products. GMPs are designed to be applied throughout the production process, from the arrival of the birds and other materials at the processing plant to final product distribution. They are essential for preventing contamination, maintaining product integrity, and protecting consumer health.

The core principles of GMPs typically include facility design and maintenance, hygiene and sanitation, personnel training, packaging and labeling, allergen control, waste management, traceability, and equipment calibration and maintenance. As well as ensuring product safety and quality for the protection of consumers, GMPs also seek to ensure employee safety.

3.1 Employee safety risks

Poultry processing involves various tasks, some of which can pose worker safety risks due to the nature of the work environment and the equipment used. There are multiple potential health risks for personnel working in a poultry processing environment. The conversion of live animals into food products has inherent challenges. When birds arrive at the processing plant, they are held in sheds to await a designated order for processing. While these areas can be partially temperature controlled with fans and misters or heaters, this can become a significantly hot or cold environment, depending on the time of year. Good environmental control is important for both bird welfare (which can have an impact on meat quality) and employee safety.

As birds enter the processing plant, they are either stunned using electrical waterbath stunning or controlled atmosphere stunning, which utilizes carbon dioxide. High levels of carbon dioxide during controlled atmosphere stunning pose an inhalation risk to employees. However, these risks are mitigated through carbon dioxide sensors which, if activated, will trigger both alarms and a ventilation system to flush the room with fresh air, removing the excess carbon dioxide.

Cuts and lacerations can occur for workers in poultry-processing plants who often use sharp tools and knives to cut and debone poultry. In addition to knives, other equipments like slicers, grinders, and cutters can pose risks if not used carefully. Improper handling of knives or machinery can lead to cuts and lacerations. Musculoskeletal injuries or ergonomic hazards can also occur due to repetitive motions, such as cutting, packaging, and lifting. The processing area is inherently wet due to the water needed to process poultry which could increase the risk of slips, trips, and falls. Poultry processing plants can also be noisy environments, potentially damaging hearing if workers are not adequately protected.

Workers may come into contact with cleaning agents, sanitizers, and other chemicals used for sanitation, which can cause skin irritation or respiratory issues if not handled properly. Dust and particles from poultry feathers and processing materials can lead to respiratory problems if workers are not provided with appropriate respiratory protection. Workers may be exposed to pathogens present in poultry, which can lead to foodborne illnesses or infections if proper hygiene and sanitation practices are not followed. Lifting and moving heavy

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loads of poultry or equipment without appropriate techniques or equipment can result in injuries.

To mitigate these risks and ensure worker safety, poultry-processing facilities implement comprehensive health and safety programs as part of their GMPs. This includes providing personal protective equipment (PPE) such as cut-resistant gloves, aprons, hearing protection, and respiratory equipment. Training workers in proper handling techniques and safety procedures is crucial as is maintaining a clean and well-organized work environment. Regular safety inspections, hazard assessments, and worker health monitoring are essential components of an effective safety program in poultry-processing plants.

3.2 Other aspects of good manufacturing practices

Good facility design and continued maintenance are essential to ensure that the processing facility is designed, constructed, and maintained to minimize the risk of contamination. This includes proper sanitation, pest control, and separation of different processing areas to prevent cross-contamination.

Hygiene and sanitation not only apply to food processing but also need to be addressed from a facility and employee perspective. Implementing strict hygiene practices for personnel, equipment, and workspaces will minimize the risk of microbial contamination. This involves regular handwashing, wearing appropriate PPE, and cleaning and sanitizing all surfaces and equipment.

Comprehensive training of processing plant workers on GMPs, hygiene practices, proper handling of poultry, and recognizing and reporting any issues or deviations from standard procedures is critical to operations. All employees, regardless of position, should be trained by a knowledgeable individual in basic food safety and personal hygiene upon hiring and then periodically thereafter. Understanding why GMPs are essential is just as important as knowing and following the plant's GMPs and policies. Teaching about why a policy or procedure is necessary is known to reduce indifference and encourage buy-in of a culture-promoting food and employee safety. Employees should be provided hard copies of plant GMPs and sign forms stating that they have read and understood those GMPs, and there should be periodic verification that GMPs are being followed.

A basic understanding of commonly encountered bacteria is also essential for plant workers. Food safety training on the role of bacteria in causing foodborne illness, how bacteria impact food spoilage, and the variety of ways that those bacteria can be spread helps reinforce why following GMPs is essential. For example, employees should understand that foodborne pathogens enter the processing plant with birds and are highly concentrated in fecal material. Understanding growth parameters such as what temperatures

slow or encourage the growth of bacteria will help justify why the processing environment and product temperatures need to be maintained and monitored.

Personal hygiene practices are another critical component of poultry processing plant GMPs to protect food and employee safety. Hands and fingernails should be clean and maintained. Employees are often restricted from wearing nail polish or artificial nails or must keep their hands gloved if needed to avoid the potential for foreign materials inadvertently entering the product flow. Hairnets and beard nets are required to prevent foreign material contamination. Proper clothing and footwear are specified to protect both the employee and the product. In vehicle traffic areas, e.g. where birds are unloaded, employees are often required to wear high-visibility safety vests. In the slaughter area of the processing plant, employees wear protective smocks, aprons, face coverings, and bump caps to reduce contact with bird fecal material and blood. Employees typically wear designated smocks and bump caps in the different remaining downstream areas of the processing plant from picking through to product distribution (often using different colors to designate a particular processing area). Using non-slip, sometimes steel-toe, footwear is also an important GMP due to the wet environment inherent to poultry processing. Other than a plain wedding band, jewelry is restricted to avoid foreign materials and for employee safety. Other activities, including eating, chewing, and spitting, are prohibited on the production floor. Many processing facilities provide break rooms, cafeteria areas for eating, and outdoor areas designated for smoking or other tobacco use.

Cleaning and maintenance of the poultry processing facility are also included in GMPs. Some examples include ensuring that employee accommodations such as break areas and restrooms are appropriate for the number of employees. These areas also need to be regularly cleaned and maintained.

Production area facility design and maintenance can include maintaining surface integrity and durability of floors and walls, using materials and equipment with cleanable surfaces with non-porous materials with smooth welds, and using covers on light fixtures to avoid the possibility of broken bulbs. Facility design factors that can aid in cleaning and maintenance also include floors sloped toward the drains, adequate drainage to allow for the anticipated rate of processing and sanitation water flow, and spacing of equipment to allow for good airflow, ease of cleaning, and accessibility for maintenance.

Clean and organized storage areas for ingredients, dry consumables, and product storage are addressed in GMPs. Storage areas should be designed and arranged to reduce cross-contamination by separating raw and finished products. Access to chemical storage areas should be restricted to authorized personnel due to the inherent danger of concentrated chemicals. The potential chemical and physical hazards of items in storage areas should be considered

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for product and employee safety. Infrequently used or obsolete equipment should be kept in a separate storage area. An inventory and log sheet should be kept in these storage areas. Establishing proper procedures for receiving, storing, and handling raw materials and components will help prevent contamination and errors.

Pest management and prevention protocols are also commonly included in GMPs to minimize the risk of pests contaminating the processing area. Multiple different pests, including rodents, birds, and insects, are managed both inside and outside the facility. Processing and storage areas are cleaned and maintained to avoid attracting pests. Physical deterrents can be used to prevent wild birds from perching or nesting around the facility. Doors should remain closed to prevent pests from entering the facility. Rodent control programs including rotating bait-in-bait stations are also part of a thorough GMP program. Insect traps near the doorway are also beneficial to minimize flying insects. When a pest control program is designed and implemented, procedures such as proper storage and application of any rodenticides or insecticides are also important to avoid any potential adulteration of product or creation of insanitary conditions.

Once a GMP plan is in place, documentation of the execution of that plan is needed. This documentation includes comprehensive and accurate records of all quality control tests and any deviations or corrective actions taken. Conducting periodic self-inspections and audits will identify any non-compliance with GMPs and allow for the implementation of corrective actions.

By adhering to these poultry processing GMPs, facilities can produce safe, high-quality poultry products that meet regulatory requirements and consumer expectations. Regulatory authorities or third-party organizations may conduct inspections and audits to verify compliance with these GMPs and ensure the safety and quality of the final poultry products.

It is also important to note that all individuals, including company employees, contractors, regulatory agency personnel, and visitors passing through processing areas, must comply with all company policies. In many poultry-processing facilities, before a visitor can enter the facility, they are required to sign a form stating that they have read, understood, and will comply with the GMPs detailed within the form.

4 Sanitation standard operating procedures

Sanitation Standard Operating Procedures are known as SSOPs. In poultry processing, SSOPs are part of a facility's prerequisite program and encompass a set of detailed written procedures and guidelines that outline the specific steps and measures to be followed for maintaining a clean and sanitary environment in the processing facility. The primary purpose of SSOPs is to

prevent contamination, control the dissemination of pathogens, and ensure the production of safe and high-quality poultry products.

Sanitation is a critical aspect of poultry processing because it directly affects the safety and quality of the final products. SSOPs cover a wide range of activities and procedures related to cleaning and sanitation in the facility. Sanitation activities are written in detail, describing the sequence of events an establishment employee must conduct to prevent direct product contamination and adulteration.

The details of sanitation procedures written in the SSOPs must include *what* is being cleaned, *who* is responsible for completing the task *when* the task is to be completed with both frequency and time, and *how* the cleaning task is to be accomplished. SSOPs are typically divided into two sections: pre-operational SSOPs and Operational SSOPs.

Pre-operational SSOPs are the steps to be taken before the start of each processing day to ensure that all equipment and work areas are adequately cleaned and sanitized. This also includes the cleaning and sanitation that occurs at the end of production. When developing SSOPs, the seven steps of sanitation need to be considered:

1 Dry cleanup;
2 Rinse;
3 Detergent application and scrubbing;
4 Final rinse;
5 Inspect and spot-clean;
6 Sanitize; and
7 Air-dry.

Cleaning is the removal of soil particles from surfaces by mechanical, manual, or chemical means. Dry cleanup begins with the removal of large particles of debris on equipment and flooring. In a poultry processing facility, this often consists of collecting and disposing of feathers, offal, and other materials on equipment or the floor. Collection and disposal of these materials is essential to minimize the organic material that goes down the drain and enters the wastewater treatment systems. Next, all surfaces from top to bottom, including floors, walls, equipment, and support structures, are rinsed to remove smaller particles. This rinse step is conducted with warm, but not hot, water to avoid protein adherence to surfaces. After rinsing, detergents are applied to all surfaces, and scrubbing with brushes removes organic matter and prevents biofilm formation. The final rinse using hot water is conducted to remove the remaining detergent and loosened organic matter. After cleaning, the facility is inspected by sanitation personnel, and if any areas are missed, they are

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spot-cleaned. With experience, sanitation personnel become acquainted with areas known to be difficult to clean and can give closer attention to these areas during the cleaning and sanitation process.

Sanitizing is the reduction of microorganisms to a safe level. It is important to note that the first five cleaning and sanitation steps must be completed before the sanitation step can be completed. If organic matter remains on surfaces, then sanitation will be ineffective.

Training and record keeping are also critical when conducting the seven steps of sanitation. Training requirements and records for employees involved in sanitation activities are part of the comprehensive record-keeping, which demonstrates compliance with SSOPs. It is important to note that poultry processing SSOPs should be specific to each processing facility, considering the unique layout, equipment, and processes involved. Regular monitoring and verification are essential to ensure SSOPs are implemented correctly and effectively to maintain a safe and sanitary processing environment. Regular internal and external audits may be conducted to assess compliance with SSOPs and ensure the highest sanitation standards in the poultry-processing facility.

5 Hazard analysis and critical control point systems: overview

HACCP systems for poultry provide a systematic approach to food safety that is specifically applied to producing and processing poultry products. The HACCP system is an internationally recognized model for effectively preventing and controlling food safety hazards. This preventive system is designed to identify, assess, and control potential hazards that could compromise the safety of the final food product. It focuses on identifying CCPs in the production process where hazards can be prevented, eliminated, or reduced to an acceptable level. In 1996, the United States Department of Agriculture, Food Safety and Inspection Service (USDA-FSIS) passed the FSIS Pathogen Reduction/ HACCP Regulation. By 1998, the HACCP system was mandatory in the meat and poultry industries. The HACCP Model for Poultry Slaughter guideline (FSIS-GD-2020-0013) provides a generic model for a poultry slaughter HACCP plan.

There are five preliminary tasks for developing a HACCP plan. The National Advisory Committee on the Microbiological Criteria of Food (NACMCF) has designated the following preliminary tasks for developing a HACCP plan:

1 Assemble a HACCP team;
2 Describe the food and its distribution;
3 Describe the intended use and the consumers of the food;

4 Construct a flow diagram that describes the process; and
5 Verify the flow diagram.

These preliminary tasks should be accomplished before considering the seven HACCP principles. The purpose of preliminary tasks is to build the foundation for which HACCP principles are applied. A HACCP team should comprise a team of individuals with the best expertise, technical knowledge, and diversity available to construct a food safety plan. The leader of an HACCP team should have in-depth knowledge and experience with food safety plans and good facilitation and decision-making skills. This knowledge base comes from HACCP certification from an accredited HACCP training program, on-the-job training, and experience implementing a HACCP plan within a poultry facility. HACCP training programs for both Introductory HACCP and Advanced HACCP are accredited through the International HACCP Alliance and are offered both in person and virtually through universities and private organizations. The rest of the team should be recruited to include persons with familiarity with the processing plant and the process for the product that the HACCP plan is being created for, with expertise encompassing a broad scope of the processing operations, including engineering, production, sanitation, management, and research and development and a variety in knowledge, skills, and experiences. Including persons encompassing broad perspectives will enhance communications and a sense of ownership in developing a HACCP plan. In particular, including management and production personnel is crucial for ensuring that the HACCP plan will be assimilated as best as possible since these persons will ultimately be held accountable for successful follow-through with the HACCP plan.

When describing the food product and its distribution, all the ingredients should be listed and a description provided on how the product is prepared. The list of ingredients will help identify which ingredients pose food safety hazards regarding allergens, susceptibility to microbiological growth, and any other considerations that might be regulated. Describing the product in terms of how the ingredients are handled and combined in cooking processes will help identify conditions that allow for microbial growth or contamination. Also, the product in terms of shelf life should be described.

The next step is to describe the intended use of the product. Defining the intended end user is essential because these considerations will impact the HACCP plan. There are nine processing categories recognized by the USDA-FSIS and are listed in 9 Code of Federal Regulations (CFR) 417.2:

1 Slaughter all species;
2 Raw product ground;
3 Raw product not ground;

4 Thermally processed commercially sterile;
5 Not heat treated shelf stable;
6 Heat treated -shelf stable;
7 Fully cooked not shelf stable;
8 Heat-treated but not fully cooked not shelf stable; and
9 Product with secondary inhibitors not shelf stable.

After describing the product, a flow diagram is constructed. The flow diagram will often be referred to in subsequent steps in the HACCP plan development process, such as hazard analysis. A flow diagram is a diagram of the steps of each process that illustrates the product flow in the processing facility. Each step is depicted as a block, and the order of steps is represented by connecting the blocks with arrows. The flow diagram should be simple. Complicated processes should be broken down into individual steps. Also, the flow diagram should include every step in the process, typically from receiving the ingredients to the point at which the product is taken by a third party, such as a distributor. After the flow diagram is constructed, it needs to be evaluated by the HACCP team to look for gaps.

6 Hazard analysis and critical control point principles and their implementation

The HACCP system consists of seven principles:

1 Hazard analysis;
2 Determine the CCPs;
3 Establish critical limits;
4 Establish a system to monitor control of the CCP;
5 Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control;
6 Establish procedures for verification to confirm that the HACCP system is working effectively; and
7 Establish documentation concerning all procedures and records appropriate to these principles and their application.

These are outlined in the following sub-sections.

6.1 Hazard analysis

The hazard analysis is conducted to identify all potential biological, chemical, and physical hazards that could occur during the production process of poultry products. When evaluating hazards, one should consider opportunities in

which hazards could be introduced in typical food processes. Some of these hazards might include raw materials and ingredients, packaging materials, metal shavings from processing equipment, chemical contaminants from processing, such as refrigerants, lubrication, cleaning agents, etc., and growth of bacteria due to improper heating, chilling, or formulation. Biological hazards can encompass bacteria, viruses, parasites, and molds. Pathogenic bacteria are the most commonly identified biological hazard in poultry processing facilities. Chemical hazards can occur naturally, with widely used additives like antimicrobials or unintentionally added chemicals. Physical hazards can result in choking or injury. These hazards may come from materials naturally present in the food, such as bone fragments. Other materials may come from handling or processing equipment such as staples, twist ties, pop-up timers, broken glass shards, bolts, nuts, and saw blade pieces.

For each step in the flow chart process, any potential hazards that may occur or be introduced in the product or ingredients are identified as biological, chemical, or physical. Whether the potential hazard is likely to happen in the presence of properly applied prerequisite programs is subsequently evaluated. The decision of whether the hazard is reasonably likely to occur needs to be justified. For any hazard that is found to be reasonably likely to occur, control measures that may be used to control the hazard are identified. Prerequisite programs reduce the likelihood of the occurrence of a hazard, while the application of a control measure will prevent it, eliminate it, or reduce it to a safe level. Each step of this process is documented in the hazard analysis.

6.2 Critical control points

Once the potential hazards have been determined, Critical Control Points (CCPs) are defined. CCPs are specific points in the production process where controls can be applied to prevent, eliminate, or reduce hazards to an acceptable level. A CCP is a point, step, or procedure in a process at which it is essential that a control can be applied to prevent, eliminate a hazard, or reduce it to a safe level. A single CCP can control multiple hazards, such as the cooking step. Sometimes several CCPs may be needed, for instance, to prevent allergen adulteration. HACCP decisions are made in response to an identified hazard that is likely to occur in the absence of its control. This determination of which hazards will be controlled at a CCP is made using hazard analysis methods. CCPs are not added to the HACCP plan to control quality or other factors. An exception to this may be a regulatory-mandated CCP, such as the zero fecal tolerance inspection required by USDA-FSIS at slaughter. Sometimes, it may not be possible to entirely eliminate or prevent the occurrence of a hazard. In some processes, especially those dealing with poultry slaughter, reducing the

occurrence of the hazard as far as possible or to a preset regulatory limit may be the only reasonable goal of the HACCP plan.

The most common CCP is a step that provides thermal destruction of pathogens. This is also one of the most effective in that it eliminates the hazard. Other CCPs may be similarly effective, such as adding acid to reduce the pH or incorporating chemical preservatives. A cooked product's holding and cooling time is also a common CCP. Usually, the CCP directly controls the process at that point, as in heating or pH adjustment. Still, sometimes it can be ancillary to the process, such as an allergen cleanup.

6.3 Critical limits

Critical limits are the maximum or minimum values that must be met at each CCP to ensure that the biological, chemical, or physical hazard is effectively controlled. It is the value placed on an attribute of a control measure at a CCP. At this chosen value, the control measure effectively prevents, eliminates, or reduces the hazard to a safe level. An accurate, critical limit is crucial to the effectiveness of a HACCP plan, as the remaining principles of HACCP are concerned with the ability of the processor to manage its CCPs and prerequisite programs. More specifically, the remaining parts of the HACCP plan (concerning that CCP) are only relevant if a critical limit is sufficient to control food safety hazards.

The critical limits in HACCP distinguish between safe and unsafe operating conditions at a CCP. They can indicate when a process is trending toward being out of control, especially when documented on a control chart during processing. This allows the operator to adjust the process before there is a loss of control. Because this is such a useful tool, plants often establish operating limits to let the operator know when actions should be taken to prevent this loss of control. Critical limits have become a regulatory mandate, and deviations from the critical limits require follow-up action and documentation. Critical limits are defined in the HACCP plan while operating limits are not included in the HACCP plan to avoid conflict and confusion.

Good critical limits should be easily and rapidly measurable, inexpensive to measure, use observation, or chemical or physical parameters that can be measured in real-time; they should not interfere with or contaminate the process; measurement procedures should be easily taught and understood, be accurate and reproducible, and be backed by verification data.

6.4 Monitoring

Monitoring a CCP consists of using a planned sequence of observations or measurements to establish whether a critical control point (CCP) is under control and to produce accurate records for future use and verification.

Monitoring is essential to ensure that the critical limits are consistently met. In addition, monitoring alerts the operator when measurements indicate that the process is trending out of control. The monitor must conduct observations or measurements according to a predetermined plan and at the specific frequency indicated by the plan. The monitor is responsible for establishing that the measured control parameters are within the critical limits and recording the information. If there is a deviation, another part of the monitor's responsibility is to begin the corrective action process. A deviation is a reading at a CCP that fails to fall within the critical limits. A written real-time record of the results of monitoring must be made.

A monitoring plan addresses who will monitor, what precisely the person is monitoring, how to conduct the monitoring, and the frequency the monitoring is to be conducted. Usually, the identity of the monitor will be specified according to the position, such as the operator, shift supervisor, or QC technician. Before being assigned responsibility, the monitor must understand the importance of the job and be trained in the correct procedures to be used. Training should include the calibration of monitoring equipment, if necessary. Also, the monitor must understand their responsibilities should a deviation occur.

6.5 Corrective actions

Defined corrective actions are to be taken when monitoring indicates that a CCP is not within the established critical limits. A critical limit is the point at which a parameter is no longer acceptable. These limits are often determined by regulatory requirements or data previously collected within the process. For example, if a cook step were defined as no less than 250°F for 30 min, and the cooking temperature was recorded at 245°F, then this would be considered a deviation from the critical limit. When a deviation occurs, corrective action must be taken to ensure that no product for which safety cannot be assured reaches the consumer. An obvious goal of corrective action is to stop producing products for which safety cannot be guaranteed. Corrective action should be taken according to a predetermined plan. If an appropriate corrective action plan is in place and authority is established, corrections can be applied expeditiously to restart production, even if plant management and quality control personnel are absent.

Corrective actions include several components. First, the processing and production of products under a deviation must be discontinued. The suspect product must be isolated and stored or disposed of to ensure it will not reach the consumer, and adjustments must be made to the process to bring it back into control. A determination of the disposition of the suspect product must be made. An accelerated monitoring and off-line testing frequency will often be instituted to ensure the adjustment or correction holds, and the corrective

action is documented for later verification activities. In cases where a repeat deviation occurs, a follow-up investigation also needs to be conducted to determine the root cause of the deviation and to determine if modification of the hazard analysis or the HACCP plan is necessary.

6.6 Verification

Verification is a collection of activities that determine the HACCP plan's validity and whether the system is operating according to the plan. Verification processes occur during the development and implementation of the HACCP plan and the maintenance of the HACCP system. Verification activities encompass all aspects of the HACCP plan, beginning with the hazard analysis through the record-keeping activities. This includes reviewing records, conducting periodic audits, and validating the HACCP plan.

The key in the verification activities is the evaluation of records to ensure that the technical aspects of the plan and the assumptions behind it are valid. The principle of verification is divided into two major aspects. Validation determines whether the plan will be effective when applied. Verification determines whether the plan is correctly followed. Validation refers to those elements of verification which focus on using scientific and technical information to determine whether an adequately implanted HACCP plan will effectively control the identified food hazards.

The components of verification are applied at various times in the process. The initial validation of the plan is to determine that the plan is technically sound, that all the hazards have been identified, and that the HACCP plan will control these hazards when implemented. Pre-shipment signoffs are completed according to USDA-FSIS regulations. Daily calibrations and records are reviewed. Subsequent validations are conducted when there are unexplained system failures, changes in the product, process, or packaging, or if new potential hazards are identified. Scheduled periodic comprehensive verification of the HACCP system is completed and includes the results of findings of regulatory or third-party audits.

Validation focuses on collecting and evaluating scientific data to validate the appropriateness of the activities in the HACCP plan. Sometimes this involves standard, established, generic scientific information, and sometimes it comes from very specialized studies relating directly to the process in question. Often, it will need to be developed using carefully planned studies conducted in the plant. In all these situations, documentation of the relevant data is required for validation. These decision-making documents are part of the HACCP plan and should be maintained with it. Verification activities must be scheduled according to a plan. There will be verification activities for each CCP noted on the HACCP Plan Summary Form and comprehensive activities

scheduled as an attachment to the form. All activities of the HACCP plan must be verified to ensure they are conducted according to plan, and all decisions must be validated with data showing that the plan, when implemented, will apply control measures that control the hazards.

6.7 Record keeping

Record keeping characterizes HACCP as much as any other principle. Records have a very practical aspect. Records archive decisions, reflect planning, standardize procedures, and document compliance. Written records standardize the procedures to be followed and provide a method for future review. Should a production problem be identified later, a review of accurate and complete records may limit the scope of products that must be recalled or destroyed. Record keeping allows the regulatory agency to change from the traditional 'snapshot in time' inspection to the HACCP audit during the entire time of operation. If litigation is forthcoming, records made in 'real-time' carry considerable weight as evidence. Unfortunately, records can document failure as well as compliance. Timely record reviews will allow immediate correction and follow-up.

Records document the application of the HACCP system. In addition to records that document the implementation of the SSOPs, these records are required by the various HACCP regulations. Processing and other pertinent information are entered into records at the time of observation using the actual values and observations obtained during monitoring. All required records, plans, and procedures are available for official review and copying at reasonable times. Confidentiality is maintained in accordance with regulations, but under some circumstances, records may be disclosed, so non-HACCP information about the company should be kept from required records.

7 The Food Safety Modernization Act

The Food Safety Modernization Act (FSMA) is a significant piece of legislation passed in the US to enhance the safety of the country's food supply. It was signed into law on January 4, 2011, and represents the most comprehensive reform of food safety regulations in several decades. The main objective of the FSMA is to shift the focus of food safety regulations from responding to contamination and foodborne illness outbreaks to preventing them from occurring in the first place.

The law addresses various aspects of the food supply chain. It places greater responsibility on food producers, processors, distributors, and importers to take preventive measures to ensure the safety of the food they handle. Many of

the requirements under FSMA had already been addressed through the GMP and SSOP prerequisite programs and HACCP.

8 Conclusion

Using the systematic approaches of GMPs, SSOPs, and HACCP plans meets the need for the production of safe and wholesome poultry products. Through these safety management and monitoring systems muscle is converted to the poultry meat that feeds the world. Further information regarding HACCP plans can be found through the USDA-FSIS HACCP Guidance website or your state HACCP Coordinator.

9 References

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