SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)
Approved by AICTE, New Delhi, Affiliated to Anna University, Chennai
Accredited by NAAC-UGC with 'A++' Grade (Cycle III) &
Accredited by NBA (B.E - CSE, EEE, ECE, Mech & B.Tech.IT)
COIMBATORE-641 035, TAMIL NADU

DEPARTMENT OF FOOD TECHNOLOGY

19FTE402 &

MEAT, FISH AND POULTRY PROCESS

TECHNOLOGY

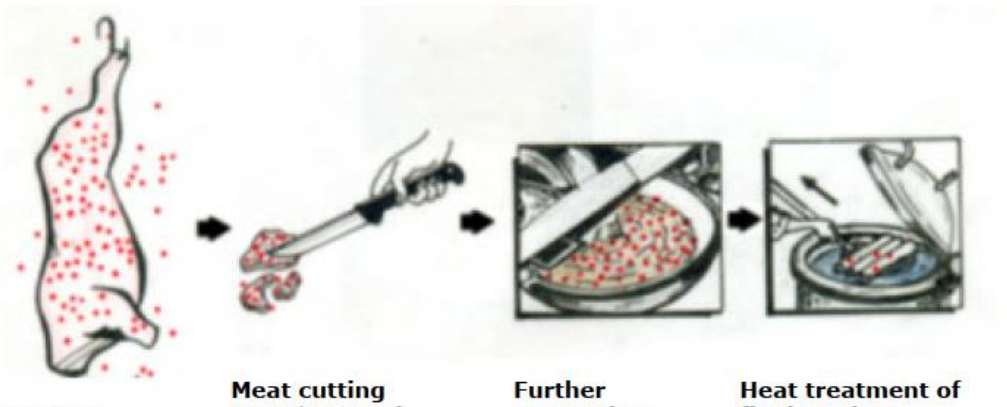
UNIT V – HYGIENE AND SANITATION

Topic: Meat Processing Hygiene

Meat processing hygiene is part of Quality Management (QM) of meat plants and refers to the hygienic measures to be taken during the various processing steps in the manufacture of meat products. Regulatory authorities usually provide the compulsory national framework for food/meat hygiene programmes through laws and regulations and monitor the implementation of such laws. At the meat industry level, it is the primary responsibility of individual enterprises to develop and apply efficient meat hygiene programmes specifically adapted to their relevant range of production. Operations in meat processing plants comprise the manufacture of value-added meat products from primary products of meat origin and non-meat origin. There are three principles of meat hygiene, which are crucial for meat processing operations.

- Prevent microbial contamination of raw materials, intermediate (semi-manufactured) goods and final products during meat product manufacture through absolute cleanliness of tools, working tables, machines as well as hands and outfits of personnel.
- Minimize microbial growth in raw materials, semi-manufactured1 goods and final products2 by storing them at a low temperature.
- Reduce or eliminate3 microbial contamination by applying heat treatment at the final processing stage for extension of shelf life of products (except dried and fermented final products, which are shelf-stable through low aw and pH)

Prepared by Ms. Mohana Priya R AP/FT



Carcass contamination during slaughtering (red dots) Unavoidable – keep as low as possible.

Meat cutting No reduction of contamination possible, but further contamination should be prevented.

Further processing No reduction of contamination possible, but prevent further contamination and create challenges / hurdles for microbial growth and survival (a_w, preservatives).

Heat treatment of final product Pasteurization (approx. 80°C): Substantial reduction of contamination, but products need refrigeration. Sterilization (above 100°C): Total elimination of contamination, products can be stored without refrigeration (in sealed food containers).

The above three principles guide meat hygiene programmes in the further processing of meat. However, meat processing hygiene is more complex. In particular, the hygienic treatment of meat before reaching the processing stage is of utmost importance for the processing quality of the meat. Failures in slaughter hygiene, meat cutting and meat handling/transportation and in the hygiene of by-products and additives will all contribute to quality losses and deterioration of the final processed meat products. Highly contaminated raw meat is unsuitable for further processing. Final products made from hygienically deficient raw meat materials are unattractive in colour, tasteless or untypical in taste with reduced shelf life due to heavy microbial loads. Moreover, there is also the risk of presence of food poisoning microorganisms, which can pose a considerable public health hazard. In the light of growing consumer consciousness as well as regionalization and globalization in trade, quality conscious meat plants need internal quality control/quality management schemes not only for the final products but also for the raw materials and the various processing steps. Such Quality Management Schemes (QM) have technical and hygienic components. Technical aspects encompass product composition, processing technologies, packaging, storage and distribution. Details on the manufacturing practice for each individual group of meat products are included in the chapters on processing technology. For the sanitary quality and safety related to meat processing, two useful schemes1 can be applied known as

- Good Hygienic Practices (GHP) and
- Hazard Analysis and Critical Control Point (HACCP) Scheme.

Both schemes are not verbally laid down in codes ready to be used for the various purposes in the meat sector although some generic examples can be accessed in handbooks or via internet.

Factory and production specific versions need to be established and compiled by taking into account official laws and regulations as well as recommended codes of practice.

Good Hygienic Practices (GHP)

Good Hygienic Practices/GHP follows general hygienic rules and applies recognized hygienic principles as well as laws and regulations issued by the competent authorities, referring to meat and meat products, equipment, premises and personnel. GHP schemes are not factory specific, they apply to all types of meat plants. They are intended to establish and maintain acceptable hygienic standards in relevant meat operations. There is more emphasis on slaughter hygiene in GHP schemes for slaughterhouses and more emphasis on meat processing hygiene in GHP schemes for meat products manufacturing enterprises. However in principle, GHP schemes remain interchangeable for similar types of meat plants.

GHP for meat processing plants refers principally to:

- Appropriate functional plant layout and sanitary design of equipment
- Raw materials that meet hygiene quality standards
- Processing methods that allow safe handling of food
- Appropriate waste and pest control measures
- Appropriate sanitation procedures (cleaning and disinfection)
- Compliance with potable water criteria
- Functional cold chain
- Regular examination of health and personal hygiene of staff
- Regular training of staff on hygiene requirements

Hazard Analysis and Critical Control Point Scheme (HACCP)

HACCP are factory and product specific strictly sanitary control schemes that shall prevent, detect, control and/or reduce to save levels accidentally occurring hazards to consumers' health. Despite GHP in place, accidental hazards cannot be ruled out and may occur at any processing step of the individual meat product. Specifically for meat processing plants, such hazards may be provoked by failures such as:

- batches of incoming raw meat materials with abnormal tissues or heavy contamination,
- breakdowns in refrigeration,
- failure in cooking/sterilization operations,
- abnormal pH or aw in raw or finished products,
- errors in levels of application of curing salts and other additives,
- technical problems in sealing of vacuum packages or cans with the risk of recontamination.

HACCP schemes serve as additional alarm systems in the interest of consumer protection to prevent such problems occurring. The revolutionary idea of HACCP is to implement control measures that focus on prevention rather than relying on end-product-testing. All relevant possible hazards in the entire production chain, from primary production to consumption of each individual product, must be identified and measures taken for their prevention. In case potential hazards should occur, they can be detected, contained or eliminated at any stage.

Prepared by Ms. Mohana Priya R AP/FT

Plant personnel have a key role to play and must be trained in hazard detection and elimination. For practical purposes, those possible hazards may be listed on specific templates for confirmation of presence or absence during routine controls. Specific control mechanisms, in the first place of physical, chemical and visual nature (temperature, pH, visual check etc.), are installed at selected control points to detect such potential hazards. These control mechanisms are designed to deliver most results almost instantly and allow immediate intervention during the processing phase of food/meat products. The need for immediate action within HACCP systems excludes microbiological control (of raw materials, semi-fabricated products, tools, equipment, and premises) as a directly applicable control measure. Microbiological control takes hours or days to obtain the results, which does not allow corrective interventions during the usually short manufacturing period. However, this does not mean that microbiological control is worthless for HACCP. Routine microbiological control carried out within the framework of GHP is an extreme helpful tool also for HACCP as its results will demonstrate the efficiency of the HACCP-system. Hygienically acceptable microbiological test results are an indicator of the proper functioning of the meat plant's HACCP scheme. HACCP is not a scheme for the assessment and improvement of the general hygienic status of a meat plant. HACCP is not designed to further raise hygienic standards. Excellent conditions as applicable for GHP-conform plants must already be in place. GHP is a prerequisite requirement for the introduction of HACCP.

The misconception still exists that HACCP is intended to raise levels of general hygiene in meat plants with low hygienic standard. HACCP is not workable where plant layout/structure, equipment and/or processing methods do not comply with good hygienic standards.

One important point to distinguish HACCP from GHP is that GHP describes process requirements and practices incl. personal hygiene of staff to ensure safety of food. The individual product is not specifically targeted. Unlike GHP, HACCP always focuses on the individual product. As technologies vary from product to product, it is obvious that separate HACCP approaches are required for each category of products.

HAZARD ANALYSIS CRITICAL CONTROL POINT (HACCP)

What is HACCP?

Internal sanitary related control and monitoring system in food plants with the aim of preventing/minimizing or eliminating **health hazards** to consumers. HACCP identifies, evaluates and controls hazards, which are significant for food safety. The characteristics of HACCP are:

- Potential for immediate **prevention measures** before or during production to counteract suspected or emerging health risks
- Exclusively **aimed at health risks** to consumers

Food plant internal control procedures based on HACCP principles have become an obligation worldwide in many countries with advanced food industries. HACCP procedures are imposed on relevant food plants by the competent authorities, whose task is to assess and evaluate the correct application and conduct of HACCP. The food plants themselves are responsible for the proper implementation of HACCP, such as monitoring of sensory, physical and chemical parameters during production and immediate intervention in case of emerging health risks and recording of results.

Requirements for introduction of HACCP schemes are yet different from region to region. In a number of countries (e.g. EU, US) meat plants in general have to comply with HACCP, whereby for smaller plants or such specializing in limited activities or products, simplifications or exceptions exist. In some other parts of the world, HACCP schemes are not yet commonly introduced. However, it can be anticipated that such plants involved in regional or global distribution of food will also be obliged to comply with HACCP principles.

Basic elements of HACCP in meat processing plants

- Every single meat product with product specific technology requires a specifically designed **individual** HACCP scheme.
- As a precondition for implementing HACCP concepts, **hazard analysis** and **risk assessment** referring to meat plant specific processing methods or products, have to be carried out.
- **Critical control points** (**CCPs**) have to be identified, critical limits be established and **monitoring systems** properly implemented.

The HACCP scheme is subdivided into seven consecutive steps ("principles"). Through these seven HACCP principles a practical approach is provided to identify potential significant hazards to consumers' health and to take relevant corrective actions:

1. Hazard analysis and risk assessment

The first principles requires initially the **exact description** of the products to be fabricated, including product composition, texture/structure, processing details (such as degree of comminuting, additives, filling, heat treatments), packaging and if applicable chemical and microbiological criteria.

Once the characteristics of each product are detailed, potential hazards to consumers' health during processing are identified. Hereunder, a summary listings of hazards are given, from where those hazards likely to be associated with the fabrication of a specific meat product can be identified.

Examples for hazards in meat processing

Biological hazards: Parasites (causing zoonotic diseases), bacteria (causing food poisoning/food borne infections and intoxications), moulds (mycotoxins causing food borne intoxications), viruses (causing food borne infections) (see page 357)

Physical hazards: Rests of unwanted materials (glass, bone fragments, animal teeth/in case of processing head meat, metal fragments such as sausage clips, broken knife blades, needles, plastics, stones)

Chemical hazards: Contaminants (heavy metals, PCB's, chemical solvents, cleaning and disinfection compounds)
Residues (veterinary drugs, feed additives, pesticides)
Food additives with risk of overdoses (nitrate/nitrite, chemical preservatives)

2. Identification of Critical Control Points (CCP)

A CCP is defined as any point or procedure in a specific food system, where loss of control may result in an unacceptable health risk. CCPs can be located at any point along the production line of a specific meat product, where biological, physical and chemical hazards may occur and where such risks can be controlled and/or eliminated. CCPs should only be established, where firm methods for control and monitoring can be applied.

CCPs must be used only for purposes of product safety. They should not be confused with control points that do **not** control safety and where loss of control does **not** lead to unacceptable health risks, e.g. reduced or strong water binding capacity of meat, knives of grinders or choppers with reduced cutting capability, mechanical problems in portioning sausages or can fillings etc. Moreover, issues of meat plant hygiene routinely covered by GHP and which are not product specific, are normally **not** CCPs. Such examples are:

- **Potable water outlets**,
- **Hot water container** for tool disinfection ("sanitizers"),
- **Cleaning** and **disinfection** equipment, chemicals and methods.
- **Sanitation measures** (e.g. periodic cleaning and disinfection of meat cutting boards)
- **Personal hygiene**

Specific preventive measures to avoid cross contamination (e.g. plant internal transports of raw materials and finished products must not cross each other)
Specific food handling procedures (e.g. meat containers must not directly be placed on the floor, but on stands, pallets etc.)

Suggested control points directly related to meat processing and therefore suited for the establishment of **CCPs** are:

- unloading bay for **raw materials** (meat and non-meat ingredients),
- **cold storage rooms**,
- meat **cutting** and **preparation facilities**,
- facility for **handling non-meat additives**,
- meat **comminuting** units (grinders, bowl choppers etc.),
- **filling equipment** and **casings**,
- **heat treatment facilities** (smokehouses, cooking vats, autoclaves),
- **packaging equipment** and **materials** (including canning),
- **cold store** for final products,

It is up to the individual meat processing plant to decide, at which points in the processing line **CCPs** should be established. This will vary from meat plant to meat plant, depending on plant lay-out equipment, type of products and also on previously experienced accidentally occurred shortcomings.

3. Establishment of Critical Limits for each CCP

Critical limits correspond to the **extreme** (highest and lowest) **values acceptable** from the point of view of product safety. This does not always imply that a numerical value has to be fixed. Monitoring may also be based on **visual observation**, e.g. dirt/faecal contamination of meat, changes to untypical colour, changes in product structure or texture. Besides such sensory parameters, numerical critical limits must be specified for each **objective control measure** at each CCP. Criteria often used include temperature, time, moisture level, pH, and water activity.

Examples
Visual check of damage to packaged incoming raw materials (rejection in case of severely damaged packages of meat materials or additives)
Visual check of contamination of raw materials (meat, fat). Discolouration (rejection of meat or fat in severe cases), meat potentially contaminated with food poisoning agents (e.g. minimal dirt contamination to be trimmed off, critical dirt or fecal contamination leads to rejection of the meat)
Temperature control of meat derived from slaughterhouses/cutting plants (e.g. $\leq +4°C$)
pH of incoming meat (e.g. < 6.0 for pork, < 5.7 for beef)
Visual check during meat cutting and grading (e.g. to separate and discard unsuitable meat tissues such as those containing parasites, abscesses, etc.)

Moisture content expressed as a_w (refers mainly to dry fermented products which should not be packaged or marketed if moisture content keeps above a certain level)
Additives (some products require a certain salt level for better stability in hot environments; nitrite levels should be high enough to inhibit bacterial growth but below toxic levels; the same applies to chemical preservatives)
Control of pasteurization parameters (ensure sufficient cooking, measured as core temperatures in products, e.g. 74°C)
Control of sterilization temperature and time for canned products (e.g. ensure that desired F-values are reached, e.g. F value 4 in fully sterilized canned products)
Visual appearance and texture of final products (greenish discolouration and slimy surfaces as signs of microbial growth, mould growth on surfaces of dried sausages)

4. Establishment of a monitoring system for each CCP

Monitoring is the **regular/periodic** measurement or observation at a CCP to determine whether a critical limit or target level has been met. The monitoring procedure must be able to detect loss of control at the CCP. Monitoring at CCPs should deliver results **rapidly** in order to enable corrective action during processing. Lengthy analytical testing is not practicable in the context. Hence most of the testing for critical limits listed in (3) is visual, physical and to some extent chemical. The slower microbiological testing (see also page 331) does not allow immediate corrective action.

Physical and chemical pattern to be instantly measured or monitored in meat processing lines include:
Temperature
Time limits see No. 3
pH
Moisture

5. Establishment of corrective actions

Corrective actions are those actions to be taken either when monitoring results show that

- a CCP has deviated from its specified critical limit or target level or
- when monitoring results indicate a trend towards loss of control

Action taken must reduce to safe level or eliminate the actual or potential hazard identified.

Corrective actions are for example

- **Reject** incoming meat with too high internal temperatures
- **Adjust** temperature for refrigerated storage and transport of meat
- **Remove** with clean knives minimal visual contamination of meat surface, **reject** heavily contaminated meat
- **Adjust** cooking and sterilization parameters (temperature/time)

- **Reject** meat with too high pH
- **Adjust** quantity of curing substances (level of nitrite, nitrite curing salt should contain 99,5% common salt and 0,5% nitrite)
- In case of dry fermented products: If a_w of processed products is too high, **stop** packaging in water vapour impermeable packages

Products with suspected hygienic deficiencies have to be separated from other products. Additional treatments may have to be applied, e.g. additional heat treatment in case of undercooking. Final judgement (if fit or unfit for consumption) has to be made by responsible, competent persons. Interventions at CCPs are carried out based on instant observation of hygienic failures/shortcomings. Corrective actions should be documented in the HACCP written records.

6. Establishment of verification procedures

Procedures are needed to ensure that the HACCP system is working correctly. Particular attention must be given to the **monitoring frequency,** which may be daily or several times a day or more frequently. **Checks on the persons** doing the monitoring should be done regularly as well as **calibration of instruments** used.

Established critical limits can be **revalidated** (changed) in the light of new developments. The system as a whole for individual products has to be reviewed in case of introducing **changes in the processing technology** such as changes in raw materials, product composition, processing equipment or packaging systems.

Test results derived from GHP **routine quality control**, in particular microbiological analysis, are valuable supplementary information within the HACCP system, support the verification process and prove the practicability of HACCP.

7. Establishment of documents and records

Documents and records must be produced commensurate with the nature and size of the food business to demonstrate the application of principles 1-6. These documents serve for the competent authorities to evaluate the efficacy of the HACCP procedure carried out at the plant. Records also help to trace causes of problems that were encountered during past production.

This documentation includes amongst others

- Certification on receipt of raw meat materials and non-meat ingredients documenting supplier compliance with processor's specifications
- CCP determinations (for each product)
- Critical limits set and results achieved for each CCP (including possible deviations from critical limits and corrective actions)
- Modifications introduced to the system in the light of changes of technology or other developments

HACCP in small meat processing plants

The rather complex HACCP approach including identification of critical control points and measurement and interpretation of test results, demonstrates the difficulties in introducing HACCP schemes in small food or meat processing enterprises. Comprehensive test systems would require a multidisciplinary approach, as well as knowledge of microbiological, chemical and physical hazards, technical processes and operation of equipment. This is available in large industries but generally not in small- to medium-scale enterprises. Flexibility should be given in these situations for simplified approaches, if HACCP schemes are to be introduced in small food businesses. Competent authorities tend to accept these views. In plants dealing with limited numbers of products or technologies, these simplified approaches can even go so far as to use GHP schemes instead of HACCP. It is obvious that in such cases GHP approaches may be more practical and less cost-intensive than

HACCP.

Two examples for preparation of HACCP plans. These are summary plans, which need to be expanded in more detail if adapted for relevant meat plants, depending on the plant layout, equipment and processing technology. Potential hazards, which are indicated as physical, chemical and biological, would have to be specified in detail. The majority of the potential hazards are “biological”, which mostly refer to microbiological risks. This corresponds with the aim of HACCP, which is prevention of health hazards to consumers. Health hazards through food are mostly caused by microbiological activity, which can be prevented if properly controlled.

The first example (cured cooked ham) is a product which is heat treated during manufacture and hence was stabilized microbiologically to a certain extent, but requires refrigerated storage. The second example refers to a meat product, which does not undergo heat treatment during processing (fresh frozen beef burger) and therefore remains particularly sensitive from the hygienic point of view.

Due to the nature of the two products, periodic microbiological tests are recommended in the framework of GHP. Periodic microbiological testing is particularly important for the product “Fresh Frozen Beef Burgers” to be marketed raw. Microbiological test results can be incorporated in HACCP. They are not a means for immediate intervention in ongoing productions (microbiological tests take too long to use their results for immediate action), but rather in the verification procedure, which serves to prove whether the HACCP system is working. Microbiological results are a means to confirm the efficiency of the meat plant internal HACCP system, when it can be proved that the established limits were not exceeded.

The Critical Control Points (CCPs) indicated are examples for the establishment of CCPs. It is up to the processing plant to increase or decrease their number according to the plant specific risk assessment.

HACCP PLAN

Product: **Cured Cooked Ham (cooked in vacuum bag and cooking mould)**

Process steps	Hazard	Target level/ Critical limit	Monitoring Procedure	Corrective action if standards are not met	Records
Reception of raw meat materials (pork hind legs without feet) **CCP**	Physical, chemical, biological	Red meat color, pH[1] not above 6.2 (DFD!), no visual defects of meat/fat/skin surfaces, core temperature ≤4°C	Check purchase specification. Inspection by random sampling of appearance, odour, temperature and pH[1]	Trim surface if only few minor visible contaminations or remaining hairs. Reject delivery, if other target levels not met	Physical characteristics of meat received, certificate of sanitary status and origin of meat. Meat temperature recordings.
Storage in reception chiller	Biological	Chiller temperature ≤4°C	Periodic temperature control	Minor temp. deviation: Adjust temperature Major temperature deviation: Reject meat[2]	Temperature/ time recordings
Cutting, deboning, trimming **CCP**	Biological	Room temperature +10°C, meat temperature ≤+7°C. Absence of alterations in meat such as abscesses, purulent or blood infiltrations	Meat temperature control. Check for meat alterations and abnormal tissues	Further cooling if meat temperature too high. Reject / discard entire meat parts with alterations such as abscesses, purulent/blood infiltrations	Record meat temperature. Record accidential findings
Evaluation and weighing of non-meat ingredients	Chemical	Nitrite content in curing salt ≤0.6% (if curing salt mix done by operator). Curing salt free of impurities. No impurities in other non-meat ingredients	Check storage conditions of nitrite salt, exact weighing of nitrite portion (if mix done by operator), Curing salt quality check. Check other non-meat ingredients for impurities	Adjust weight of nitrite portion correctly or use freshly mixed curing salt. Replace other non-meat ingredients	Records of status and expiration dates of non-meat ingredients. Results of weighing nitrite portions
Preparation and injection of curing brine **CCP**	Physical, chemical biological	Brine temperature at injection ≤+4°C	Check brine temperature	No utilization of curing brines failing temperature and purity requirements	Record conditions encountered
Tumbling	Biological	Room temperature ≤+4°C, time ≤ 8 hours	Check temperature/ time	Adjust room temperature if too high	Temperature/ time recording
Packaging, moulding	Biological	Cleanliness of synthetic materials, tightness of enclosure by clip or seal	Check quality of materials and clipping/ sealing.	Reject unsuitable synthetic bags, correct clipping/ sealing failures	Record on packaging material, equipment
Cooking **CCP**	Biological	Internal cooking temperature (core temperature) ≥+70°C. Temperature of cooking media +78°C	Check core temperature by electronic temperature measurement	Increase cooking temperature or prolong cooking time until required core temperature is reached	Record temperature of production batch. Record any deviation in temperature
Cooling (in water)	Biological	Cooling to +15°C core temperature in ice water	Check core temperature / time. Check cooling water temperature	Add ice if cooling water temperature too high	Time/ temperature record of cooling period
Storing (chiller)	Biological	Temperature of cooling room ≤+4°C	Check temperature daily	Adjust temperature as the case may be	Record of cold chain temperature

CCP = Proposed Critical Control Point

[1] pH to be measured at topside (Musc. gracilis)

[2] Alternatively: check meat and decide on further utilization for processing into hygienically less sensitive products.

HACCP PLAN

Product: **Fresh Frozen Beef Burgers (extended, with salt and spices, vacuum packed)**

Process steps	Hazard	Target level/ Critical limit	Monitoring Procedure	Corrective action if standards are not met	Records
Reception of raw meat materials (beef, boneless) **CCP**	Physical, chemical, biological	Internal meat temperature ≤+4°C, red meat colour, fresh slightly acidic odour, no visible contamination, no discoloration, not slimy, no other defects	Check purchase specification. Inspection of meat surfaces by random sampling. Check internal meat temperature	Reject delivery, if target levels not met	Physical characteristics of meat received, certificate of sanitary status and origin of meat. Meat temperature recordings
Storage in reception chiller	Biological	Room temperature ≤+4°C. Meat internal temperature ≤+4°C	Temperature control of chilling room and meat (internal)	Minor temperature deviation: Adjust chiller temperature Major temperature deviation: Reject meat[1]	Temperature/time recordings of chiller. Temperature recordings of meat
Weighing and composition of non-meat ingredients	Physical, chemical	Visibly clean non-meat ingredients (common salt, no curing salt to be used)	Check salt, spices and extenders for impurities	Reject suspected batches of non-meat ingredients	Record of status and expiration dates for non-meat ingredients
Prepare meat for grinding, effect grinding	Biological	Room temperature ≤+10°C. Period from delivery of meat from chiller to pass through grinder maximum 20 minutes. Meat free of grossly abnormal tissues and post-dressing contamination	Check period of product flow. Check for abnormal tissues and post-dressing contamination	Improvement in product flow. Discard meat parts with abnormal tissues, post dressing contamination	Product flow/ temperature recording
Mixing of meat with ingredients **CCP**	Biological	No further increase of contamination. Room temperature ≤+10°C. Period from grinding to completion of mixing/blending maximum 30 minutes. Temperature of meat/meat ingredients mix ≤+10°C	Check period of product flow. Check mix temperature	Minor deviations: Adjust time/temperature regime. Major deviations: Reject batch	Product flow/ temperature recording
Patty moulding	Biological	Carry out immediately after mixing. No significant product temperature increase	Temperature/time control	Increase process speed. Return mix to chiller if no immediate moulding process	Product flow/ temperature recording
Freezing **CCP**	Biological	Blast freezer at -35°C	Temperature control	Adjust freezer temperature	Record blast freezer temperatures
Packaging	Biological	Clean packaging materials	Check packaging failures	Adjust packaging machine in case of insufficient vacuum packaging	Results of packaging
Freezer storage	Biological	Temperature of storage freezer -18°C to -30°C	Continuous temperature check	Rise of temperature: immediate identification and correction of temperature problems, transfer to alternative storage freezer if long-term problem	Continuous freezer temperature records

CCP = Proposed Critical Control Point