Quality Control In The Meat Industry
Application of the HACCP In The Manufacturing Line of Canned Meat

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Abstract

The hazard analysis critical control point (-HACCP) is a system directed to identify microbiological hazards existing in an industrial operation or process in order to identify critical control points (CCP) in which such hazards can be controlled and tests systems established to be able to monitor or supervise control effectiveness. This system allows previous failure protection and correction, improving quality costs due to microbiological defects and almost avoiding final supercontrol, which despite offering relative guarantee of the product may result in product destruction in case of late detection of failure, with the consequent added cost. This work covers in a practical way the implementation of the HACCP system to the manufacturing line of canned meat.

Introduction

The liberalization of food products trade requires to ensure the health quality at the point of origin by means of appropriate processing, which allowed to rely on the safety and harmlessness of the final products (ICMSF, 1991). The fulfillment of this requirement is dictated by European Union Directives, and by the Spanish regulations which transpose the Directives to the Spanish legal code.

The General Directives on Food Hygiene 93/43/CEE establish that all the companies in the food sector, and therefore meat and poultry industries, should set up a product self-control system based on the Hazard Analysis and Critical Control (HACCP) system, extending this regulation not only to the processing industry in the European Union, but also to distribution companies, catering companies, hotels and restaurants (-Doce, 1993).

The HACCP system tries to assess the microbiological hazards existing in a process or practice in order to identify the critical control points (CCPs) in which these hazards can be controlled, and to establish systems based mainly in chemical and physical essays and in visual evaluation for monitoring and watching the control effectiveness (Moreno, 1996).

This system was first presented concisely during the National Conference on Food Protection in 1971 (APHA, 1972). In the meat and poultry sector in Spain, studies in this issue have known a great increase lately, and many valuable contributions have appeared (ICMSF, 1991; Moreno, 1993, 1994; Sierra *et al.*, 1996; Pardo *et al.*, 1997a, 1997b, 1997c, 1998a, 1998b).

The main objective of this work is to undertake practically the implementation of the principles and methods of the HACCP system in the manufacturing line of canned meat.

Materials and Methods

Canned meat are products prepared with edible portions of authorised species of livestock, poultry or game, which have been subjected during its processing to the action of heat (thermal treatment), achieving a sterilization value (F0) of at least 3 minutes, having been previously introduced in hermetically sealed containers.

In order to be able to apply correctly the principles of the HACCP system, the following tasks were performed:

1) Creation of a multidisciplinary team,
2) Complete description of products,
3) Study of consumer's expected use,
4) Description of the process or flow diagram,
5) Several tests in the process,
6) List of all biological, chemical or physical hazards which can be reasonably foreseen in each stage,
7) Study of preventive measures,
8) Determination of CCP, specifying the critical limit for each preventive measure,
9) Supervision of measures or observations to demonstrate that a CCP is under control,
10) Formulation of all corrective measures which are specific for each CCP of the system,
11) Creation of procedures to verify that the HACCP system works properly,
12) Development of the necessary actions to ensure that the HACCP system introduced is really efficient, allowing also system feedback in case of detection of deviations.

Results and Discussion

This section presents the process flow diagram (**fig 1.**), from raw material reception to issue of the final product, according to the field of study and taking into account observations carried out in the meat industry. We also include a synoptic (**table 1**) showing the application process for each stage, describing the main predictable hazards as well as the preventive measures to be considered to minimize or eliminate such hazard. The synoptic table reflects also the type of CCP, the critical limit for each preventive measure and the necessary supervision to demonstrate that a critical point is under control. Aiming at solving the possible deviations over or under the critical limits established, all corrective measures specific for each control point of the system have been clearly stated. Finally, there is an enumeration of the necessary parameters (temperature control in chambers, water analysis, etc.) to provide data about what is happening in the process at a specific moment.

Stage 1:
Admission of raw Materials. Water Supply

Hazards: In this stage all the components of the final product are received; these include meat, Condiments, spices and additives. Despite these components will be subjected to a subsequent thermal sterilization process, a severe hygienic control will be followed to avoid possible contamination, discarding all the raw materials with any abnormality in its freshness of its sanitary state, since in both cases the final product quality will be seriously affected. Note that the efficacy of the sterilization process diminish when the initial number of microorganisms is very high, and

preventive measures to avoid excessive growing are recommended. An adequate water supply, namely mains water, is unavoidable. The main hazard will be the multiple microbial contamination sources during raw materials reception and during previous transportation.

Preventive measures: they will be aimed to avoid or palliate the possible microbiological contamination sources, such as: 1) ensure appropriate temperature and hygienic conditions during transportation; 2) guarantee adequate conditions for condiments, additives and spices; 3) standardize suppliers to encourage in the companies a supplier qualification system which guaranteed the raw materials; 4) water supply will be of adequate quality.

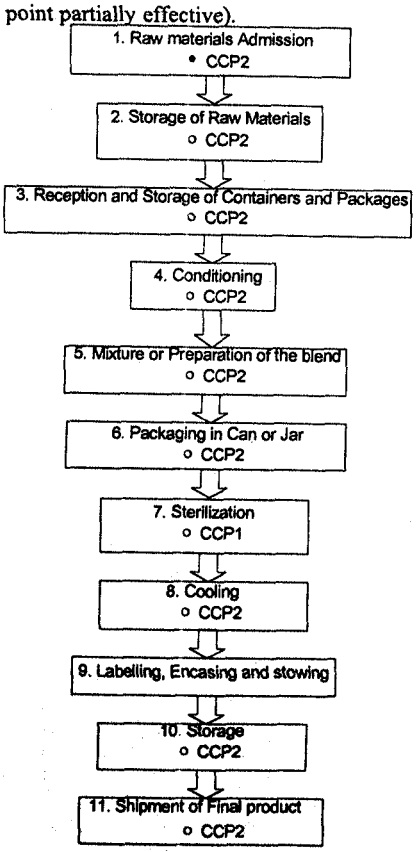
Critical levels: Special attention will be given to temperature during transportation for assurance of meeting the hygienic standards established by legislation for the raw materials arriving to the process line: 1) refrigerated meat will always be below 7 ° C; 2) frozen meat will always be below –12 ° C; 3) offal products should be below 3 ° C; 4) Poultry and rabbit meat should be below 4 ° C; 5) water shall comply with the Directive 80/778/CEE for drinking water.

Surveillance: temperature, hygienic conditions and product compatibility will be controlled for each shipment by visual inspection in the transportation mean. The fulfillment of the purchase specifications will be checked. Regarding the water quality, chlorine and microbiological analysis will be carried out daily while physiochemical and analysis will be carried out every fortnight.

Corrective measures: the main corrective measure will be the turn down of unsuitable raw material, which could affect a whole shipment or a part of it. If the purchase specifications not fulfilled do not affect the shipment innocuousness, the supplier will be informed, and in case of repeated failure, the standardization of the supplier will be withdrawn. Chlorine will be added to the water whenever water analysis would indicate contamination. A further step will be to change the water supply source. If the water is taken from the mains, the connection point will be changed, and if the problem persists the whole installation will be checked.

Records: Records will be taken with applied corrective measures, such as total or partial shipment turndown. Chlorine, microbiological and physiochemical controls of water, and analysis of the incoming shipments will also be recorded, as well as the final report.

Fig. 1 - Flow diagram of the processing line of cannedmeat ●: Important contamination; O: Slight contamination; CCP1: Critcal control point totally effective; CCP2 Critcal control point partially effective).



Stage 2:

Storage of raw materials

Hazards: In this stage the raw materials are stored in stores or chambers (refrigeration or freezing) suitably for each product until the conditioning process. The main hazard, as in the previous stage, will be the microbial contamination or the increase of previous contamination.

Preventive measures: the main preventive measure will be to establish an appropriate time-temperature combination in the storage rooms, specially for refrigerated meat, since it is the most sensitive product to alteration. Furthermore, the rooms will ensure the adequate conditions of cleanness and asepsis. To ensure an effective stock rotation which prevented long retention periods in the room, an effective stocking system will be established. This system will take into account a good air circulation in the rooms, avoiding excessive loading which would create different thermal zones in them, an adequate stowage avoiding the contact of raw materials with floor and walls, and adequate cleaning and disinfecting of all the tools used. In order to prevent future contaminations, an adequate storage of the ingredients will be also necessary, taking special care in using promptly the open packages.

Critical levels: storage temperature will be below 7° C for refrigerated meat, 3 ° C for offal products, 4 ° C for poultry and rabbit meat, and –12 ° C for frozen meat. Storage time should be appropriate.

Hygienic conditions will be ensured for rooms and tools and an adequate storage and stowing system will be followed.

Surveillance: a tight control will be established on room temperature, which will be recorded with thermometers. Periodic visual control will be followed to evaluate the state of the stored raw materials, as well as to control the conditions and length of storage. The application of the cleaning and disinfecting program will be surveyed by means of microbiological analysis of worktops, equipment and tools.

Corrective Measures: they will be aimed to correct storage conditions when any problem is detected, as could be incorrect temperature or inadequate storage conditions, and could result in the turndown of any raw material that could be altered during this storage stage, and could not be used without a health hazard for the consumer.

Records: it is important to remember that we are in front of a documentation and verification system and therefore all corrective measures applied should be recorded and documented. Room temperatures will also be recorded.

Stage 3:

Reception and Storage of Containers and packages

Hazards: the acceptance of defective containers and packages which could give rise to contamination of spoilage (mainly microbiological) of the final product, is the main hazard in this stage.

Preventive measures: once the good state of containers and packages has been checked, they will be properly stored, avoiding stock accumulation and contact with the floor, in rooms which complied

with the adequate hygienic measures in cleaning, clearing of insects and rats. To guarantee the good condition of containers and packages, supplier standardization is recommended. This should be accomplished by visiting the supplier and checking that the hygienic norms and adequate containers and packages composition are fulfilled.

Critical Levels: all the material will fulfill the buyer specifications, and the conditions specified by the R. D. 397/1990, of March 16, regarding the general conditions of the materials, other than polymeric, used for contact with food. Containers and packages will be properly stored.

Surveillance: visual inspection will be carried out on the stowage conditions of containers and packages, as well as on hygienic conditions of the store and storage conditions (stock rotation, air circulation, etc.).

Corrective measures: turndown of defective containers and packages. Repeated turndown for the same supplier will imply the withdrawal of the standardization. Whenever a problem appears in the storage conditions, the consequent corrective measures will be taken.

Records: Corrective actions taken. In case of a shipment turndown the reason for the rejection, the shipment number and the reception day will be recorded.

Stage 4:
Conditioning

Hazards: this stage includes such operations as thawing, cutting, boning, grinding, etc. These manipulations imply new microbial contamination hazards, or an increase of previous contamination levels.

Preventive measures: as for other stages, the time-temperature binomial is essential, that is, working at a low temperature during the shortest possible time, and using the best hygienic conditions during manipulation with tools and equipment. Ensuring a correct application of the cleaning and disinfecting program of worktops, tools and equipment to protect the raw material from microbial growth.

Critical Level: Satisfactory handling practices will be needed, with satisfactory hygienic conditions and conditioning room temperature below 12 ° C.

Surveillance: visual inspection of the state of equipment, tools and plant before and during the operation will be carried out. Worker manipulation practices will be surveyed. Room temperature will be checked with recording thermometers.

Corrective measures: Wrong working conditions will be corrected immediately, possibly requiring turndown of unsuitable raw material, as well as changes in the cleaning and disinfecting program.

Records: working room temperature and corrective measures applied to working conditions and to the cleaning and disinfecting program.

Stage 5:
Mixture or blend preparation

Hazards: in this stage the meat, previously conditioned, is mixed with flavouring, spices and additives. The greatest hazard will be given by microbial contamination level. Another hazard in this stage is an excessive or incorrect additive incorporation.

Preventive measures: the time-temperature binomial will be essential, as well as hygienic manipulation conditions and rigorous cleaning, disinfecting and tools and equipment maintenance. A specific formulation for each product obtained in the plant is needed, stating clearly the dose for each additive.

Critical levels: good manipulating practices will be needed during the whole process and also satisfactory hygienic conditions in manipulation and in equipment, tools and plant, as well as correct dosage of authorised additives within the established legal range. Temperature of the room for blend preparation should be below 12 ° C during working hours.

Surveillance: visual inspection of hygienic conditions and tools and equipment functioning will be carried out, checking also good manipulating conditions, ingredients weight control – specially for additives – and checking correct application of the cleaning and disinfecting program by means of microbiological analysis of worktops after application of the program.

Corrective measures: these measures are aimed to correct working conditions of equipment or tools, or the cleaning and disinfecting program. Turn-down of defective blend will be decided whenever a health hazard could exist for the consumer.

Records: all corrective actions will remain documented and recorded. Temperature of room for blend preparation will also be recorded.

Stage 6:
Packaging in can or jar: cleaning, filling, closing

Hazards: in this stage the blend prepared as described above is introduced in perfectly clean metal cans or glass jars which are then correctly closed and sealed. In the three sub- stages the main hazard will be microbial contamination or increase of previous contamination.

Preventive measures: within the preventive measures we highlight the use of drinking water for packages cleaning, good manipulation and hygienic conditions, and correct operation of the filling and closing equipment. If the filling operation is manual, hygienic measures will be stressed, identifying and excluding possible carriers of food poisoning germs.

Critical levels: appropriate hygienic conditions of packages, good manipulation practices, hygienic conditions during package sealing and hermetic nature of the seal need to be ensured. If the seal is not hermetic, external microorganisms could get into package through the pores.

Surveillance: it will include visual inspection of the package condition, filling operation, sealing operation and seal integrity. Periodically, the equipment will be checked since disarrangement is quite usual.

Corrective measures: we highlight the change in the water supply source, correction of the cleaning and disinfecting program, correction of working conditions, turndown of defective packages and fitting of filling and sealing equipment. If the seal integrity is not perfect, the packages will be discarded and the process will be checked, fitting and tuning the sealers.

Records: all corrective actions taken will be documented and recorded, as for example seal integrity controls and equipment maintenance.

Table 1- Application synoptic of the processing line of canned meat

STAGE	HAZARDS	PREVENTIVE MEASURES	CCP	CRITICAL LEVELS	SURVEILLANCE	CORRECTIVE MEASURES	RECORDS
1. Raw materials admission water supply	*microbial contamination	*Adequate transport Conditions for raw materials* [illegible] *Adequate water supply source	2	*T<7° C for refrigerated meat *T<-12° C for frozen meat *T<3° C for offal products *T<4° C for refrigerated poultry and rabbit *Satisfy drinking water requirements (Directive 80/778/CCE)	*Means of transport control (T, hygiene) *Batch control: T and organoleptic features *Purchase specifications *water physicochemical and microbiological analysis and chlorine control	*Unsuitable material turndown. *Supplier standardization withdrawal *Chlorine addition if necessary *Change water supply	*Corrective measures. *Results from water supply *analysis of incoming shipments and final report
2. Storage of raw materials	*Microbial Contamination	*adequate time/T *Store health conditions (cleanness, disinfection) *Correct stowing system	2	*T<7° C for refrigerated meat *T<-12° C for frozen meat *T< 3° C for offal products *T<4° C for refrigerated poultry and rabbit *Adequate storage time *Satisfactory store health conditions *Appropriate storage conditions	*State of raw material *Temperature recording *preservation time *Stowage conditions *Correct application of the cleaning and disinfecting program (CDP)	*Correction of storage conditions *Unsuitable material turndown	*Temperature recording *Corrective measures
3. Reception of containers and packages	*Microbial contamination	*packaging checking *appropriate stowage *Suppliers standardization	2	*Satisfy purchase specifications *Appropriate stowage conditions	*Hygienic stowing conditions *Storage conditions	*Packages turndown *Withdrawal of suppliers standardization *Correction of storage conditions	*corrective measures
4. Conditioning	*Microbial contamination	*adequate time / T *Satisfactory handling conditions practices (SHP) *Hygienic conditions of tools and equipment	2	*Satisfactory handling *Satisfactory hygienic conditions *Room T under 12° C	*Appropriate handling. *Correct application of the CDP *Inspection of temperature chart	*Correction of working conditions *Correction of CDP	*Corrective measures *Temperature recording
5. Mixture or blend preparation	*Microbial contamination *Incorrect or excessive additive incorporation	*Adequate time/ T *Satisfactory handling conditions *Hygienic conditions of tools and equipment *Specific formulation for each product	2	*SHP *Authorized additives limit *Satisfactory hygienic conditions *Room T under 12° C	*Hygienic conditions *Weighting control *Corrective application of the CDP	*Correction of working conditions *correction of CDP *Unsuitable material turndown if necessary	*Corrective measures *Room temperature
6. Packaging in can or jar	*Microbial contamination	*Use of drinking water for cleaning of packages *Satisfactory handling conditions *Appropriate functioning of filing and sealing equipment	2	*Satisfactory hygienic conditions. *SHP *Seal integrity	*Packages cleanness and filing process *Checking of seal integrity *Checking of equipment	*Change of water supply *Correction of working conditions *correction of CDP *Packages turndown *Equipment fitting	*Corrective measures *Seal integrity controls *Equipment maintenance
7. Sterilization	*Microbial survival	*Appropriate time/ T *Correct retort operation	2	*Satisfy technical specifications of the process *Satisfy hygienic conditions *F_o > 3 minutes	*Calibration of equipment and devices Time/ T	*Product turndown *reprocessing *Correction of working conditions	*Corrective measures *thermal treatment charts
8. Cooling	*Microbial contamination	*Use of chlorinated drinking water *Hygienic conditions of equipment *Avoid manipulate wet packages	2	*Satisfy drinking water requirements (Directive 80/778/CEE) *Satisfy defined process	*Water time-temperature control *Chlorine level in water *Microbial analysis of product *Seal integrity	*Correct process *Check product *Product turndown	*Incubation results *Corrective measures *Water analysis
9. Labeling, encasing and stowing	*Contaminatio n by package breakage	*Appropriate stowage conditions		*Satisfactory package conditions	*Package conditions	*Turndown of broken or defective packages	*Package breakage
10. Storage	*Product alteration	*Store hygienic conditions *Adequate store T *Correct storage	2	*Avoid extreme T *Satisfactory hygienic conditions *Adequate stowage conditions	*Appropriate manipulation *Correct application of CDP *Stowage conditions	*Unsuitable products turndown *Correction of storage conditions *Correction of CDP	*Corrective measures *Storage conditions

Stage 7:

Sterilization

Hazards: in this stage the product, introduced in hermetically sealed containers, is subjected to a thermal treatment. Obviously the major hazard in this stage will be an inadequate thermal treatment allowing microbial survival.

Preventive measures: canned meat includes a wide range of products regarding shape, size, and composition, which will require different temperature and time conditions during treatment; therefore the process parameters should be specified for each product. Furthermore, the correct functioning of the equipment will also be essential.

Critical Levels: technical specifications for each process should be fulfilled, as outlined above, and good hygienic conditions will be required. Commercial sterility achieved with the thermal treatment should ensure a lethality value

F_0 of at least 3 minutes.

Surveillance: the equipment and devices will be periodically calibrated and the time temperature chart will be recorded, using control marks for temperature in each shipment.

Corrective measures: in case of an inadequate thermal treatment, the product will be reprocessed or discarded. Process conditions will be modified if necessary.

Records: all corrective measures will remain documented and recorded. Thermal history charts and control marks will also be recorded.

Stage 8:
Cooling:

Once the thermal treatment is finished the containers with the product are subjected to a quick cooling; the most efficient system consists in introducing the containers in a big vessel filled with cold water. If cooling is not fast enough there could be microbial growth or spores germination of possible survivors of thermophilus species. Another possible source of microbial contamination could be from psicrotroph species found in the cooling water which could get into the container due to defective sealing.

Preventive Measures: within the preventive measures we highlight using chlorinated drinking water for the cooling operation and avoiding direct manipulation of containers while they are moist.

Critical levels: Cooling water shall comply with the Directive 80/778/CEE for drinking water. The cooling process will be carried out as described above.

Surveillance: Cooling time and cooling water temperature will be surveyed to achieve a fast cooling of the product. Quality control of the final product will be carried out in this stage, since it is the stage previous to storing; its frequency will depend on the results obtained, production volume, type of product and level of hazard. The seal integrity will also be checked to ensure the lack of contamination from outside.

Corrective measures: the cooling process will be checked when product alteration is detected; furthermore the product will be analyzed to determine if its turndown is necessary.

Records: the results of the incubation trials and the water analysis will be recorded, as well as the corrective measures applied.

Stage 9:
Labeling, encasing and stowing

The labeling, encasing and stowing operations are performed previous to the storage. The only hazard in this stage is product contamination by container breakage due to bad stowage; in that case the product will be discarded immediately and will not be a risk for the consumer health, and therefore it will not be considered a critical control point.

Stage 10:
Storing:

Hazards: once the process is finished, the products will be stored in appropriate rooms. The main hazard will be the deterioration of the product due to inappropriate storage conditions.

Preventive Measures: hygienic conditions and appropriate room temperature are important factors. Furthermore, stowing conditions will be designed to avoid damages to packages and to allow a good air circulation.

Critical levels: extreme environmental conditions will be avoided. Appropriate storage and stowing conditions will be ensured and the rooms will be in good state of cleanliness and clear of rats and insects.

Surveillance: visual inspection will be carried out regularly to be sure of correct manipulation and application of the cleaning and disinfecting program. Storage conditions will also be controlled.

Corrective Measures: the main corrective measure will be the turndown of products which are unsuitable for consumption. Afterwards, the storage conditions and the cleaning and disinfecting program will be corrected to avoid future turndowns.

Records: all corrective measures taken and the incidence report of the storage conditions will be recorded.

Stage 11:
Finished product shipment:

Hazards: transportation will be carried out in authorised vehicles at adequate temperature. The major hazard will be the possible product deterioration by inadequate transportation or stowing conditions.

Preventive measures: appropriate hygiene during manipulation of the product and appropriate stowing conditions will be necessary. Furthermore, avoiding high temperatures during transportation will be a useful preventive measure.

Critical levels: incompatible products will not be put together with the canned products during transportation and extreme temperatures will be avoided. Appropriate stowing conditions will be a must.

Surveillance: it is important to survey the correct application transportation and stowing conditions.

Corrective measures: they will be aimed to correct hygienic and stowing conditions during shipment and transportation.

Records: all corrective actions taken will get documented ad recorded.

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