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Review:

HAZARD ANALYSIS AND CRITICAL CONTROL POINTS IN MEAT INDUSTRY

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INTRODUCTION:

Hazard Analysis Critical Control Points is a System which identifies, evaluates and controls hazards that are significant for food safety (CAC, 1997). HACCP is a tool to assess hazards and establish control systems that focus on prevention rather than relying mainly on end-product testing. Any HACCP system is capable of accommodating change, such as advances in equipment design, processing procedures or technological developments.

The Hazard Analysis and Critical Control Point (HACCP) system is a science-based system created to identify specific hazards and actions to control them in order to ensure food safety and quality. It can be considered an efficient tool for both the food industry and health authorities in preventing food borne diseases (Vela and Fernandez, 2003). A hazard is a biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect (CAC, 1997).

HACCP has become synonymous with food safety. It is a worldwide-recognized systematic and preventive approach that addresses biological, chemical and physical hazards through anticipation and prevention, rather than through end-product inspection and testing. The effective implementation of HACCP will enhance the ability of companies to: protect and enhance brands and private labels, promote consumer confidence and conform to regulatory and market requirements.

International food trade, and foreign travel, are increasing, bringing important social and economic benefits. But this also makes the spread of illness around

the world easier. Eating habits too, have undergone major change in many countries over the last two decades and new food production, preparation and distribution techniques have developed to reflect this. Effective hygiene control, therefore, is vital to avoid the adverse human health and economic consequences of food borne illness, food borne injury, and food spoilage. Everyone, including farmers and growers, manufacturers and processors, food handlers and consumers, has a responsibility to assure that food is safe and suitable for consumption.

Food safety has become a common concern worldwide, making public health agencies and governments of several countries look for more efficient ways to monitor production chains (Makiya and Rotondaro, 2002). The hazard analysis and critical control points (HACCP) system is widely recognized as a management tool capable of ensuring food safety. The keyword of the system is "prevention" (Mortimore and Wallace, 1998) by means of the identification of possible contaminations before they occur, and of the definition of control measures to maximize food safety in every step of the process (Cullor, 1997). Compared with traditional methods of inspection and quality control based on the analysis of finished products, HACCP facilitates a stricter control of contaminations (Stevenson, 1990). The HACCP system is recognized as an important tool in the reduction of food borne diseases (FBDs), and it is a global reference in terms of food safety control. It is recommended by the World Health Organization, the International Commission on Microbiological Specifications for Foods, the *Codex Alimentarius*, and food regulatory agencies in various countries.

History of HACCP

- In the 1960s the Pillsbury Company developed a program for the production of safe foods for NASA space program.
- 1971: The Pillsbury HACCP system was published first time for public and documented in the USA. Introduced during the National Conference on Food Protection, 1971.Three principles: (1) Identification and assessment of hazards, (2) Determination of critical control points to control any identified hazard, (3) Establishment of systems to monitor critical control points.
- 1985: Report: "Microbiological Criteria for Foods and Food Ingredients"– Approve HACCP. The National Academy of Science (NAS) recommended the use of the system. Worldwide the system became used and the FAO/WHO Codex Alimentarius cited the system in the Codex.
- 1989: NACMCF proposed 7 principles of HACCP application Published in 1989, 1st. Revision in 1992, 2nd. Revision (latest) in 1997 Released immediately on the Internet and Published in 1998 (Journal of Food Protection).
- 1997: The current HACCP guideline was developed in 1997 by the Codex Alimentarius Commission.

Application of HACCP in meat industry

There are a variety of potential hazards for most foods, including meat and meat products. Many of these

hazards can occur during the processing stage. Because most meat plants are capable of processing high volumes of meat products, food-borne disease outbreaks can potentially affect large sectors of the population. A hazard may be an unacceptable level of disease-causing microorganisms. Hazards can also be caused by chemicals that reach the food inadvertently through various environmental sources or during food processing, preparation or storage. Hazards can result from food additives being used in excess of functional or culinary needs. While the types of hazards can vary, the results are all the same - a food- borne disease outbreak.

The HACCP system controls or eliminates those hazards, which cause foodborne disease outbreaks by identifying critical operations and providing effective and efficient methods for monitoring and controlling them. The final outcome is the highest assurance of food safety. The HACCP system identifies and controls the steps in a meat plant, which are critical to producing safe and wholesome meat products. It examines and monitors the entire process so that the final product is not contaminated - it is not a test for contamination, after it may have taken place. The ultimate goal of a HACCP system is to eliminate all public health risk.

Prerequisites for the Implementation of the HACCP Plan

Before the application of HACCP principles, some "prerequisite programs," such as good manufacturing practices and cleaning procedures, should be established in order to ensure basic hygiene conditions in the processing plant. These prerequisite programs, if correctly implemented, will determine the principles for correct handling of foodstuffs, making HACCP more efficient and easy to manage (Wallace and Williams, 2001). GMP are sets of sanitation guidelines for the food handlers (methods, habits and work) and processing operation in a food plant to assure a safe, wholesome and quality product. Most successful implementation of HACCP is done within an environment of well-managed pre-requisite programmers' (Codex Committee on Food Hygiene, 1997). The main prerequisite programs are good manufacturing practices and sanitation standard operating procedures. These programs involve the following aspects: physical structure and maintenance of the premises, water supply, handler health and personal hygiene, pest control, sanitization of premises and equipment, calibration of instruments, quality control of raw material and ingredients, recall procedures, and measures related to consumer complaints. The lack or inadequate implementation of prerequisite programs may lead to more complex HACCP plans, with a greater number of CCPs to be monitored, once hygienic aspects have also been included.

Steps for HACCP Implementation

Hazard Analysis and Critical Control Point system methodology and implementation is basically guided by guidelines on HACCP implementation from these three leading authorities:

- The Codex Alimentarius Commission (CAC, 1997)
- Campden and Chorleywood Food Research Association

- Mortimore and Wallace's HACCP: *A Practical Approach*

Application of HACCP is divided in two part:

1) The Pre HACCP steps: Necessary prior to implementation of the seven (7) HACCP principles.
2) The HACCP System: Describe the seven (7) principles of the HACCP system

Part 1:- The Pre HACCP steps

1. Assemble HACCP team:

The HACCP team, responsible for creating and implementing the plan, should be multidisciplinary and knowledgeable regarding production, engineering, health, microbiology, and quality assurance issues. The team leader should have knowledge of the manufacturing process, leadership skills, and easy access to managers (Mayes, 1994). The team should collectively have skills in the areas of, the food production process; Principles and practice of food safety; Current management systems operating on the premises; Communications and teamwork; Change management; HACCP principles; other skills appropriate for the premises. An essential element in making HACCP team effective is involving operational staff and motivating them to contribute (McAloon, 2001). The size of the team (or teams) will vary depending on the distribution of skills but may typically range from three to six persons.

2. Describe Product and Identify intended use

A full description of the product should be drawn up, including relevant safety information such as: composition, physical/chemical structure (including Aw, pH, etc), microcidal/static treatments (heat treatment, freezing, brining, smoking, etc), packaging, shelf life (including spoilage potential); and storage conditions and method of distribution. Within businesses with multiple products, for example, catering operations, it may be effective to group products with similar characteristics or processing steps, for the purpose of development of the HACCP plan (USDA, 1999).

- The following questions should be answered when you described the product:

- What is the **common name** of the product?
- **How** is the product to be **used**?
- What **type of packaging** encloses the product?
- What is the length of the **shelf life** of the product, at what **temperature**?
- **Where** will the product be **sold**?
- What **labeling instructions** are needed?
- Are **special distributions controls** needed?

The intended use should be based on the expected uses of the product by the end user or consumer. In specific cases, vulnerable groups of the population, e.g. institutional feeding, may have to be considered.

3. Develop a Flow Diagram describing the Process

If a process flow diagram does not already exist, the HACCP team must construct one based on their knowledge of the process. This diagram provides the foundation for the hazard analysis and must be detailed and complete, listing consecutive steps for the process. Inputs that must be included are all raw materials, additives, ingredients and food contact materials that will form part of the end product. It is, therefore, necessary to physically confirm the process flow diagram by means of discuss the process flow diagram with each operator in the process to ensure it accurately describes the process steps and all inputs and outputs and observe the work that is carried out at each process step and confirm that the process flow diagram is correct.

The flowchart should describe all the steps, identify the equipment, and define working conditions (temperature, pressure, etc.). Flowcharts are the basis for the identification of hazards and preventive measures, and they should be periodically validated and adjusted, when necessary, to reflect the real processing conditions**.**

Verify the Flow Diagram

Steps must be taken to confirm the processing operation against the flow diagram during all stages and hours of operation and amend the flow diagram where appropriate. The confirmation of the flow diagram should be performed by a person or persons with sufficient knowledge of the processing operation.

4. On-site confirmation of flow diagram

The HACCP team should confirm the processing operation against the flow diagram during all stages and hours of operation and amend the flow diagram where appropriate.

In any case the accuracy and actuality of the flow diagrams and layout shall be verified by the HACCP team for compliance with the documented situation. This verification shall be repeated periodically (at least annually) in order to identify and document modifications to the process installation and layout. These periodic verifications shall be part of the verification procedure.

Part 2:- The HACCP system

1. List all potential hazards associated with each step, conduct a hazard analysis, and consider any measures to control identified hazards (PRINCIPLE 1)

The HACCP team should list all of the hazards that may be reasonably expected to occur at each step according to the scope from primary production, processing, manufacture, and distribution until the point of consumption.

The types of hazards that must be considered are:

1. Biological hazards :

They are frequently associated with the raw materials. Inadequate hygiene practices may result in a loss of microbial control and become a hazard (Metaxopoulos *et al.*, 2003).

- Biological hazards may be also introduced during processing :
  - By people involved in the processing.
  - From the environment in which foods are processed.
  - From the ingredients in the products.
  - From the processing themselves.
- The most relevant pathogens according to meat products are:

Salmonella : Red meat and poultry

Staphylococcus : Processed and fermented meats

C. perfringenes : Cooked meats

B. cereus : Processed semi cooked meats, meat pies

E. coli : Red meats, poultry

2. Chemical hazard :

Naturally occurring chemical hazards are those that are natural constituents of foods. e.g., aflatoxins, mycotoxins and shellfish toxins **(**Moss, 1996; Asefa *et al.*, 2011). Added chemical hazards are those which are intentionally (or sometimes unintentionally) added to food. e.g., a component of animal feed or drinking water, animal drugs, pesticides, lubricants, cleaners, paints **(**Rhodehamel, 1992**).**

3. Physical hazard :A physical hazard is a component of a food that is unexpected and may cause illness or injury to the person consuming the food. Foreign materials such as glass, metal or plastic are familiar physical hazards in meat and poultry products.

They find entry from:

- Contaminated raw materials.
- Poorly designed or poorly maintained facilities and equipment.
- Contaminated packaging materials.
- Inattention to details by employees with key responsibilities.

2. Determine the CCPs (Principle 2)

Critical Control Point is a point or step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level**,** (Mortimore and Wallace, 1997). A logical consistent approach is required to identify Critical Control Points (CCPs). A Decision Tree may be used to ensure consistency and accuracy of determination. The Decision tree can be applied to ALL hazard types.v

3. Establish Critical Limits (Principle 3)

A critical limit is the **maximum or minimum value** to which a physical, biological or chemical **hazard must be controlled** at a critical control point (Moberg, 1992). Some critical limits are defined in Legislation, e.g. chilled storage temperature of meat, pH, water activity, etc. Other critical limits may need to be determined by experimental techniques or by reviewing case studies or research work. There are two types of critical limits. A critical limit can be an upper limit where a set amount or level cannot be exceeded. A critical limit can also be a lower limit where a minimum amount is required to produce the safe effect. A grinding room temperature of 50° F to help control pathogen growth is upper critical limit. An example of a lower critical limit would be the addition of an acidifier to inhibit bacterial growth.

4. Establish Monitoring Procedures (Principle 4)

Monitoring is the scheduled measurement or observation of a CCP relative to its critical limits. The monitoring procedures must be able to detect loss of control at the CCP. Further, monitoring should ideally provide this information in time to make adjustments to ensure control of the process to prevent violating the critical limits. Where possible, process adjustments should be made when monitoring results indicate a trend towards loss of control at a CCP. The adjustments should be taken before a deviation occurs. Data derived from monitoring must be evaluated by a designated person with knowledge and authority to carry out corrective actions when indicated. If monitoring is not continuous, then the amount or frequency of monitoring must be sufficient to guarantee the CCP is in control. Most monitoring procedures for CCPs will need to be done rapidly because they relate to online processes and there will not be time for lengthy analytical testing. Physical and chemical measurements are often preferred to microbiological testing because they may be done rapidly and can often indicate the microbiological control of the product. All records and documents associated with monitoring CCPs must be signed by the person(s) doing the monitoring and by a responsible reviewing official(s) of the company.

5. Establish Corrective Actions (Principle 5)

Specific corrective actions must be developed for each CCP in the HACCP system in order to deal with deviations when they occur. The actions must ensure that the CCP has been brought under control. Actions taken must also include proper disposition of the affected product. Deviation and product disposition procedures must be documented in the HACCP record keeping.

- Questions to be considered when you are developing corrective action :
  - How will people be informed when the deviation occurs?
  - If the person doing the monitoring procedure is the one to first notice the deviation, who will that person contact?
  - Who will be responsible for controlling any product that may have been affected by the deviation?

- How should that person decide how much of the product needs to be controlled?
- How will you decide what was the cause of the deviation?
- Who in the company needs to approve any modifications to the plan?

6. Verify the HACCP Study (Principle 6)

Verification is the sum of activities other than monitoring that determines the validity and compliance with HACCP program. The following methods of evaluation may be used: review of the flowchart for the process, review of the critical limits, review of CCP monitoring records, laboratory analyses of the finished product, and analysis of deviations in critical limits.

The Verification system should examine the entire HACCP system, its decisions and its records, (Prince, 1992).

Ongoing verification ensures that HACCP plan is working effectively on a day-to-day basis

I. Calibrating monitoring instruments.

II. Observing monitoring activities and corrective actions.

7. Establish Documentation and Record keeping (Principle 7)

All CCP monitoring procedures should be recorded in control charts, which also have to show the necessary corrective actions. The record keeping system should, whenever possible, be integrated in the routine charts of the company to prevent the build-up of time-consuming forms to be completed. Only necessary changes should be made in the charts, such as fields for describing corrective actions and for the signature of the person responsible for the procedure (Mortimore and Wallace, 1998).

Advantages of HACCP

The HACCP system, as it applies to food safety management, uses the approach of controlling critical points in food handling to prevent food safety problems. The system, which is science based and systematic, identifies specific hazards and measures for their control to ensure the safety of food. HACCP is based on prevention and reduces the reliance on end-product inspection and testing. The HACCP system can be applied throughout the food chain from the primary producer to the consumer. Besides enhancing food safety, other benefits of applying HACCP include more effective use of resources, savings to the food industry and more timely response to food safety problems.

Benefit of HACCP is following:

- Preventing possible hazards and supplying safe products.
- Minimizing risks of food poisoning.
- Making increase consumer confidence.
- Making increase industry authenticity.

- Minimizing product cost.
- Making easier marketing.
- Increasing products shelf life.
- Making solve product problems systematically.
- Making product export easy, due to its international acceptability.
- Increasing food safety and hygiene conscious of food industry stuff. (Pawar and Purwar 2013).

Limitation of HACCP system

- Developing, implementing and monitoring requires a team of HACCP experts in the plant.
- Demanding on staff and time.
- Small operators find financial problem in implementation.
- Operators producing a large number of products may also experience difficulty in implementing HACCP system.

Who can use HACCP?

All businesses involved in the food supply chain from producers to retailers can use HACCP. It can be applied throughout the food chain from primary production to final consumption and its implementation should be guided by scientific evidence of risks to human health.

The following sectors/business can use HACCP:

Fruits & Vegetables, Dairy Products, Meat & Meat Products, Fish & Fishery Products, Spices & Condiments, Nuts & Nut Products, Cereals, Bakery & Confectionary, Restaurants, Hotels, Fast Food Operations etc. (http//www.National Centre for HACCP Certification.html).

Why the need of HACCP?

Motivations for adopting HACCP may include the need to:

- Reduce the incidence of food borne disease.
- Ensure a safe food supply for the population.
- Promote (facilitate) trade in food products.

More than 200 known diseases are transmitted through food. The causes of food borne illness include viruses, bacteria, parasites, toxins, metals and prions, and the symptoms of food borne illness range from mild gastroenteritis to life-threatening neurologic, hepatic, and renal Syndromes. Acute diarrhoeal illness is very common worldwide and estimated to account for 1.8 million childhood deaths annually, predominantly in developing countries (WHO, 2005). The burden of diarrhoeal illness is substantial in developed countries as well (Scallan *et al*., 2005). A number of studies are under way that aims to provide a better understanding of the global public health burden of gastroenteritis and food borne

diseases (Flint *et al*., 2005). In industrialized countries the percentage of population suffering from foodborne illness has been reported to be up to 30 %. In India an estimated 4,00,000 children below five years age die each year due to diarrhea (Sudershan *et al*., 2009).

Efficacy of HACCP

One would need to have and compare the same data from the same operators, obtained both before and after implementation of the HACCP system. e.g. *Salmonella* prevalence data before and after the introduction of HACCP in the USA.

***Salmonella* prevalence in animals (%)**			
	Cattle	**Pigs**	**Broilers**
Pre-HACCP	1.0-2.7	8.7	20
Post-HACCP	0.4-2.2	5.4	10.7

CONCLUSION:

HACCP system is a scientific approach to quality control. It is a preventative system that takes the whole chain of food production into consideration before biological, chemical and/or physical hazards affect the safety of food products.

The successful implementation of this HACCP plan depends on the correction of the deviations in the prerequisite programs **(SSOP, GMP, etc).**

"It is widely acknowledged that, although absolute safety in food production is unattainable, effective HACCP implementation is the surest way of delivering safe food."

There has been decrease in the incidence rate of certain food borne diseases including Campylobacteriosis and Salmonellosis in the USA and the UK, and it has been suggested that the decrease is due to introduction of HACCP system.

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