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Review Article

SAFETY AND RISK MANAGEMENT IN MEAT AND MEAT PRODUCT MANUFACTURE BASE FOR APPLYING HACCP

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ABSTRACT

Providing of food hygiene for all food processing as a part of approach of food hygiene management, to reduce the incidence of food borne disease is the need of an hour. Training is important in raising industry awareness about hazard Analysis Critical Control Point (HACCP) which ensures the potential benefits of HACCP to the food industry, regulatory authorities and ultimately to the consumer. HACCP provides a means to identify and assess potential hazard in food production and establish preventive control procedures for those hazards. The application of HACCP is actively encouraged and usually required to all of the food supply chain. In meat processing we must create a high level of qualified potency in the safety of the product produced by a processing system both by individual processors as well as processors operating under the system of control. Meat processing is generally a process step to prevent and reduce hazards to safe levels by applying the HACCP.

Keyword: HACCP, Food safety, Hazard, Food hygiene management, Meat processing

INTRODUCTION

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*et al.,* 2002). The purveyance of food hygiene training for all food handlers, as part of a combined approach to food hygiene management, could help reduce the incidence of food-borne disease (Ehiri*et al.,* 1996). The effectiveness of food hygiene training could be greatly improved where training is based on a suitable constellation of approaches designed in-line with effective health education theories and models. Such models could contribute to the development of approaches which consider not only the provision of information aimed at modifying attitudes and behaviors but also the social and environmental factors which impinge on food safety (Ehiri*et al.,* 1997).

The HACCP system is widely recognized as a management tool capable of ensuring food safety. Since the 1960's, food safety professionals have recognized the importance of HACCP principles for controlling risk factors that directly contribute to food borne illness. The use of HACCP principles at all levels of the food chain is however compulsory under European Union (EU) Directive 93/43/ EEC and Regulation 852/2004/EC (EU, 1993, 2004; Conter*et al.,* 2007). Hazard Analysis Critical Control Point HACCP is proven management system providing consumers confidence of food safety. The system is based on focusing control at operation points, which could be critical to the food safety (Barendsz*et al*. 2003; Kijowski and Maleszka 2005; Koło_yn-Krajewska and Sikora 1999; Bryan 1990; Gramza, 2008). The principles of HACCP embody the concept of active managerial control by encouraging participation in a system that ensures foodborne illness risk factors are controlled. The basic reality of the HACCP system is that it is possible to recognize the hazard potential vicious practice at early stage of food operations. In the case of meat hygiene, the qualitative recognition of unseen microbiological and chemical contamination, rather than grossly-apparent abnormalities are now the most important sources of hazards to human health which has led to increasing demands for a more systematic regulatory approach to combat these hazards (Hathaway, 1993).

FOOD SAFETY BASED ON HACCP

HACCP is a risk management system that identifies, evaluates, and control hazards related to food safety throughout the food supply chain. The hazard analysis and critical control point system is widely recognized as a management tool capable of ensuring food safety. The keyword of the system is prevention by means of the identification of possible contaminations before they occur and the definition of control measures is maximize food safety in every step of the process (Cullor, 1997; Leitao, 1993). HACCP program can be implemented to control physical, biological, and chemical risks throughout the operations. The plan helps regulatory authorities and customers that you are taking every reasonable precaution to assure food safety. It also helps to reduce contamination related to food losses and improve the design of new food

products (Mortomore*et al.* 1998). Fig 1 shows the ISO 22000 food safety management systems (FSMS) and ISO 9001 quality management system (QMS).

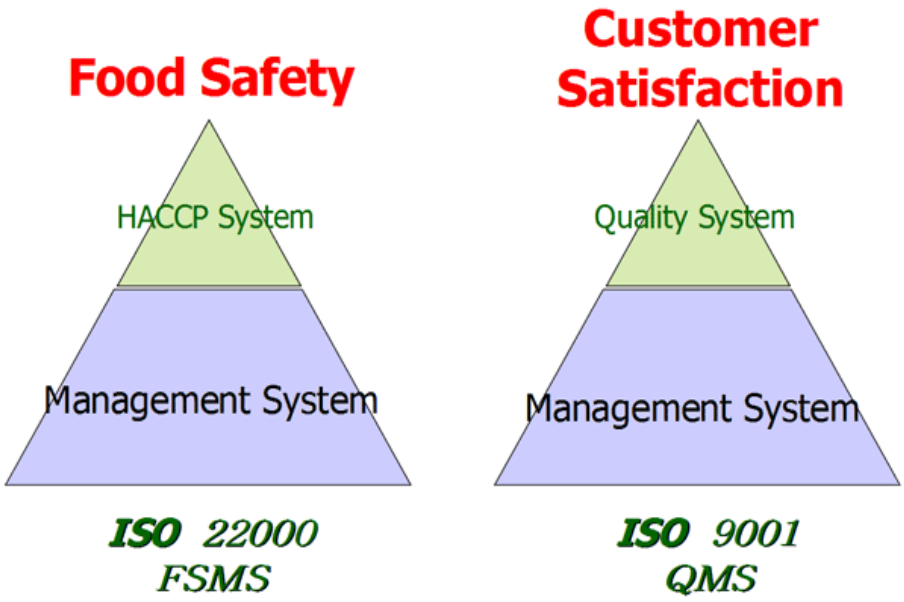


Figure 1: Food safety and customer satisfaction (Quality Resource Corporation, 2009)

ISO 22000:

Quality Resource Corporation (2009) reported ISO 22000 standards systematize, and they have 7 principles and 12 steps of HACCP and this is the requirement of Food Safety Management Systems (FSMS) which has its goals to ensuring security in all industries in the food chain. ISO 22000 specifies the requirements for a FSMS that combines the following generally recognized key elements to ensure food safety along the food chain up to the point of final consumption:

- Interactive communication
- System management
- Prerequisite programs
- HACCP principles

The organization shall establish, document, implement and maintain an effective food safety management system and update it when necessary in accordance with the requirements of ISO22000

Standard.

ISO 9001:

Quality Resource Corporation (2009) explained ISO 9001 as the standard of customer satisfaction because; it guarantees the customer's safety about received services or buying products through inspecting and certifying the Quality Management System of a company. Also, constructing this system in your company provides a major advantage in increasing constitutional improvement, customer's confidence and so on. The organization shall establish, document, implement and maintain a quality management system and continually improve its effectiveness in accordance with the requirements of ISO 9001 Standard. The organization shall;

a) Determine the processes needed for the quality management system and their application throughout the organization,

b) Determine the sequence and interaction of these processes,

c) Determine criteria and methods needed to ensure that both the operation and control of these processes are effective,

d) Ensure the availability of resources and information necessary to support the operation and monitoring of these processes,

e) Monitor, measure where applicable, and analyze these processes, and

f) Implement actions necessary to achieve planned results and continual improvement of these processes.

HACCP PLAN PRINCIPLES

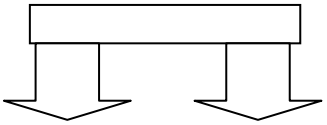
Pierrson (1992) explained basic HACCP principles are as:

- Identification of food hazards and the necessary risk control measures
- Identification of the food safety Critical Control Points (CCPs)
- Determination of the critical limits for each CCP
- Establish monitoring procedures for CCPs
- Plan and take corrective action when critical limits are exceeded
- Establish verification procedures for the HACCP FSMS system
- Establish documentation and record keeping for the HACCP FSMS system.

Prerequisites for the accomplishment 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. 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 (Brasil, 1998). Fig 2 shows the basic conditions for HACCP implementation in the food industry.

Basic conditions



HACCP team:	**Flowchart:**
• Knowledgeable • Committed • Involved in routine activities in the plant • Trained (GMP, SSOP, HACCP)	• Details of the product • Production step by step • Equipment • Working conditions • Constantly updated and adjusted

Figure 2: Basic conditions for HACCP implementation in the food industry (Sueli*et al.,* 2002).

Impact of HACCP for Food Safety:

The increasing acceptance of HACCP as the most cost-effective means of controlling food borne disease and the resultant proliferation of HACCP application has highlighted the need for clear guidance on the training requirements necessary for effective HACCP implementation (Mayes, 1994). During the past decades, the quest for safety has been challenged by important changes in food production, such as innovations in manufacturing processes, reduced intervals between production and consumption, increased product shelf life, and increased prevalence of some microorganisms (Stevenson, 1990: Bauman, 1990).

HACCP is an important tool in modern quality management in the food industry, ensuring the integrity of the product, preventing FBDs, and protecting the health of the consumer. HACCP will only become effective when its principles are correctly and broadly applied at all stages of the food production chain. Some of the reasons for the recent increase in FBD frequency all over the world may be failures in implementation or limited application of HACCP, mainly in small companies; lack of knowledge of the final consumer, keeping inadequate food handling practices alive; and low rates of HACCP adoption in developing countries, where most of the FBD outbreaks occur.

APPLYING HACCP IN THE MEAT INDUSTRY

The Food Safety Act 1990 applies to all stages of the food chain and enables the introduction of regulations, such as the Meat Products (Hygiene) Regulations 1994. Acceptance of HACCP is very important to the meat industry because an enormous quantity of these products moves in international commerce. A HACCP program for the supplier of raw meat products will also help monitor microbial condition of products entering the processing plant.

Someone who is working in the meat industry, it would be familiar with the slaughter and butchery practices applied the slaughterhouse. Also, they should have contact with the farmers to become familiar with information about the agricultural practices applied from the birth of the animal to its arrival at the slaughterhouse. The animal is itself contributory of pathogenic and spoilage organisms, it should be every stage of slaughtering of the animal comprises a critical control point that should be controlled by applying of HACCP (Rhea, 2009). Also workers in the meat and poultry industry should be wearing several types of safety and other equipment to effort to protect of itself (United States Government Accountability Office, 2005).

During the slaughter process the organism can contaminate the carcass. USDA's nationwide beef microbiological Baseline collection program for steers and Heifers reported an incidence of 0.2% of *E.coli* 0159:H7 on raw beef carcasses (no *E.coli* 0157:H7 was detected on pork carcasses in the market hog study). *E.coli* 0157:H7 contamination in foods is most often associated with animal products, especially ground beef, although cross contamination from animal food to other foods has been reported. *E.coli* 0157:h6 is pathogen that can survive both refrigerated and freezer storage. If present, the bacterium can multiply very slowly at 44°F and may present in a fermented product because it is able to survive in an environment of pH 3.6 to 7.0 for substantial periods, unless it is destroyed by heat or other procedures in the process. The specific procedures to be used for destruction of *E.coli* 0157:H7often include a combination of controls for pH, A_w control, temperature and microflora in raw materials. Fig 3 shows typically wear several types of safety and other equipment in an effort to protect themselves from injury and illness.

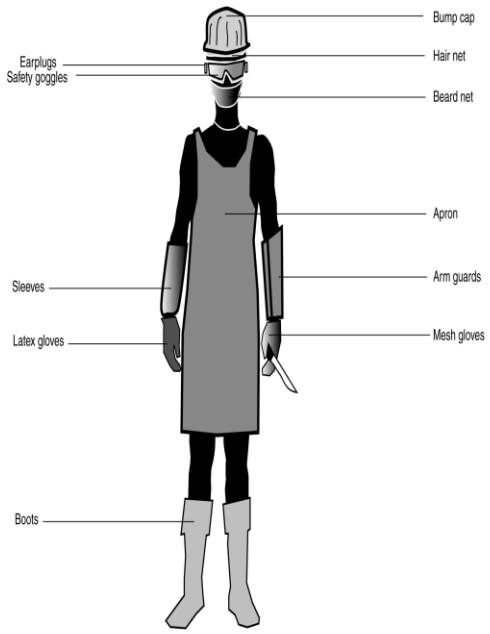


Figure 3: Safety and Other Equipment Worn by Meat and Poultry Production Workers

Source: Government Accountability Office, 2005

Applying HACCP in meat processing:

In meat processing a high level of qualified potency must be created for the safety of the product produced by a processing system both by individual processors as well as processors operating under the system of control. Meat processing is generally a process step to prevent and reduce hazards to safe levels by applying HACCP. The first step determines the kinds of hazards associated with the raw meat such as microbiological hazards, chemical hazards and physical hazards. The main hazard associated with raw meat is microbiological and these are controlled both at the farm and abattoir level. The addition of curing salt and starter culture are also the critical control points. It is essential that these ingredients should be of high quality in order to prevent the further contamination and should function correctly to provide favorable condition for the growth of useful microorganisms used in fermented products. The fermentation stage is another important CCP because of the rapid fall in the pH value which results the inhibition of the growth of most pathogenic microorganisms. The heating and drying stages may reduce the number of organisms and inhibit their growth (Rhea, 2009). Fig 4 shows the production of raw fermented meat. To facilitate the HACCP can discuss assemble the evolution of a HACCP plan for refrigeration beef ravioli. Fig 5 shows flow diagrams of the process of beef ravioli (detailed cooking) and it considered the HACCP principle and the product description can explain such as**:**

Product Characteristics: Refrigeration beef ravioli

Raw Materials: Raw frozen de-boned beef

Additive: No

Ingredient: Dry spices, salt, sugar and flour

Method of preservation: Heat treatment and refrigeration

Shelf life: under 3°C for 2 weeks

Storage and distribution

Condition: under 3°C

Inner packaging: PE-Plastic bag

Packaging: Carton box

Special labeling: No

Customer preparation: To be cooked before consumption.

Sensitive population: no for general consumption.

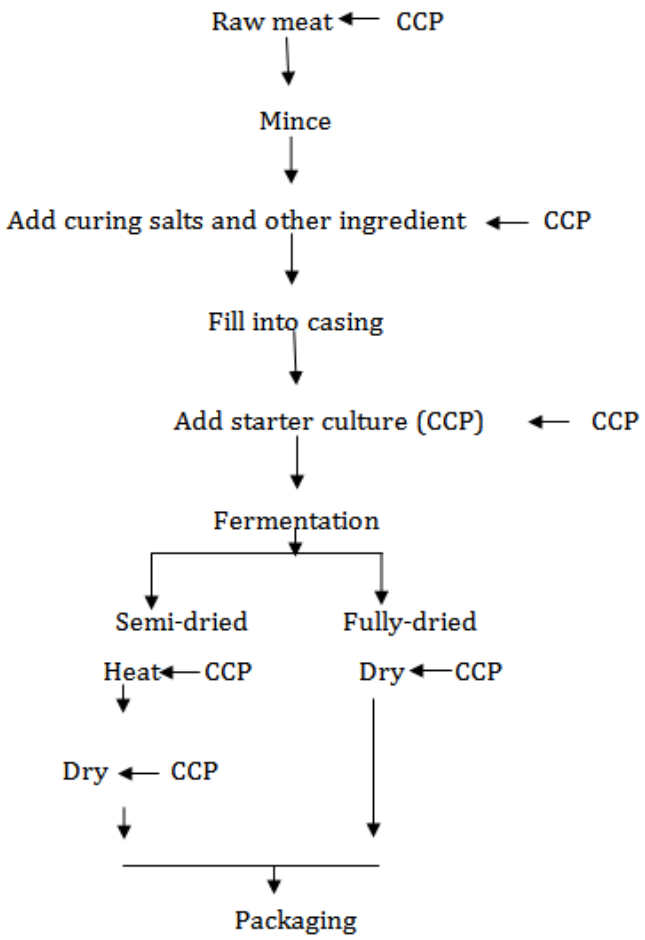


Figure 4: Flow diagram for the production of raw fermented meat (Rhea, 2009)

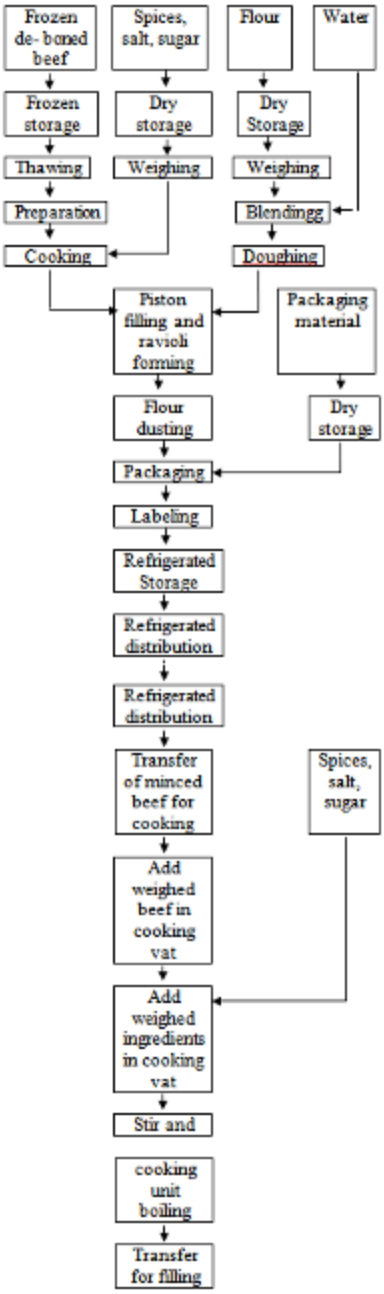


Figure 5: flow diagram process of beef ravioli (detailed cooking) (Rhea, 2009)

Control of microbial hazard related meat and poultry product:

Red meats and poultry come from warm-blooded animals and as such, their microbial flora is heterogeneous, consisting of mesophilic and psychrotropic bacteria. These bacteria include pathogenic species originated from the animal itself, from the environment and bacterial species introduced during slaughter and processing of raw products. Raw meat and poultry have the a_w>0.09 and a pH range of 5-7, which is an optimal combination for microbial growth (The American Meat Institute Foundation, 1997). Meat

and poultry require a wide array of control measures in their processing. Cured meats and some sausage products utilize additives such as salt, nitrate and sugars with processing procedures such as cooking and smoking. Salt may restrict bacterial flora to salt- tolerant species. Smoking and cooking will destroy many vegetative cells. However the processing environment, product handling and packaging may introduce microorganisms including pathogens into packaged product that also must be considered. There is substantial history of meat and poultry products that meet criteria. In addition to the above criteria certain combinations of pH, $a_{w,}$ and other factors can be used to prevent pathogen levels which otherwise increaseswhen meat products are held at an ambient temperatures. Products processed in the retail environment are exempt from the HACCP rule should also follow this guideline and maintain documentation about the control of hazards (The American Meat Institute Foundation, 1997).

GOOD MANUFACTURING PRACTICES

Good manufacturing practices (GMPs) are programs that comprise the basic universal steps and procedures that control operating conditions within establishments and ensure favorable condition for the production of safe food. GMPs are the control factors that related to the entire operation and are not process specific. GMPs include such programs as pest control, recall procedures, construction/maintenance and sanitation (The American Meat Institute Foundation, 1997). In order to ensure that GMPs are carried out there are step by step description that instruct individuals as to how, when and what tasks are to be performed for required GMPs. Special attention is directed toward the microbiological conditions of the product to emphasis on the quality and safety of processed products (The American Meat Institute Foundation, 1997).

FOOD SAFETY HAZARD

The food safety goals now being adopted by regulatory authorities profess to incorporate the philosophy that resources should be allocated towards identifying and controlling the hazards of greatest public health importance and in doing so, there should be cost-effective allocation of resources (Hatway 1993; snijdersa*et al.* 1989; Stenholm, and Waggoner, 1989).

A food safety hazard is a biological, chemical and physical agent, or condition of food, with the potential to cause harm or an adverse health effect when the food is eaten. Food safety hazards can be classed as (Rejendran, 2010; *NSW HSC 2014*):

- Biological such as microorganisms
- Chemical such as chemicals, pesticides, cleaning agents and allergens
- Physical foreign objects that are not supposed to be in the food, such as timber, glass, packaging material and naturally occurring objects – bones, dust and grit.

Any business should aim to reduce the risk of these hazards in its food processing and service,

ensuring the food is safe to consume. A food safety program outlines the systems in place to keep food safe and procedures which reduce the risk of the hazards which may occur in the food production and service business (*NSW HSC 2014*).

Physical hazards:

Physical hazards which can be found in food include:

- Objects naturally present in the food (animal hair, bone chips, leaves, etc.)
- Objects occurring in agriculture (dirt, manure, leaves, etc.)
- Objects added during processing (glass, plastic, hair, metal, etc.).

Reducing physical hazards is relatively simple in most hospitality businesses as they are physically visible in the food. They are normally controlled by procedures such as a visual inspection of food and good kitchen procedures such as no wood or glass policy, and keeping the food covered (*NSW HSC 2014*).

Chemical hazard:

Chemical hazards which can be found in food include:

- Naturally occurring poisonous chemicals (poisonous plants such as rhubarb leaves and mushrooms, poisonous animals such as puffer fish, algal blooms, mold toxins, etc.)
- Chemicals added via water
- Agricultural chemicals from soils, plants and animals (pesticides, antibiotics, dips, heavy metals, etc.)
- Chemicals added during food processing (additives, cleaners, etc.).

Some people have an allergic reaction to certain ingredients or parts of food. Common allergens include: soybeans and their products, seams, cereals containing gluten, milk and milk product, sulphites, egg and egg products, peanuts and their products, fish and fish products (*NSW HSC 2014*).

Chemical hazards in foods can be controlled by:

- Purchasing from an approved supplier
- Covering food and protecting it from contamination
- Having an allergen awareness, and strategies to prevent cross contamination from allergens
- Separate chemical storage area, away from food
- Use of food safe chemicals within the food preparation areas
- Correct cleaning procedures.

Biological hazards:

Hazards which live within the foods and can occur from multiple sources. These microorganisms (commonly called “germs”) are so small they can only be seen under a microscope. Not all microorganisms are harmful to humans. Pathogens are the microorganisms which cause harm to humans, when they reach a high level in food. Some examples are (*NSW HSC 2014*):

- Bacteria e.g. salmonella, staphylococcus aureus, bacillus cereus
- Viruses e.g. hepatitis A, influenza

- Yeasts
- Molds
- Protozoa e.g. Guardia

Most food poisoning illness is a result of these microorganisms growing in food. When food is in moist and warm conditions, they multiply to an "infective dose" which makes a person ill. Most food poisoning occurs due to the continued growth to dangerous levels of microorganisms, particularly bacteria, in food. Food handlers should know about food poisoning bacteria and the conditions they require for growth, to ensure food borne illness is avoided. It is important to be aware of the different types of food safety hazards which may pose a significant risk to the safety of your customers. Situations when food safety hazards are likely to pose a significant risk are:

- Handling "potentially hazardous foods" which are susceptible to microorganisms contamination and growth. These are low acid, high protein foods such as meat, eggs, poultry, sea food and dairy items.
- Handling raw food and fresh foods
- Handling food with your hands, rather than using equipment
- Cooking food - food needs to be cooked thoroughly to kill microorganisms
- Chilling food - food needs to be chilled quickly to reduce the growth of microorganisms
- Defrosting foods
- Reheating foods
- Displaying food on buffets or self service
- Preparing food in temperatures in which microorganisms grow rapidly (5°C- 60°C).

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