FOOD SAFETY BY IMPLEMENTATION OF HACCP IN DAIRY AND FOOD INDUSTRY

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Introduction

Food is the basic requirement for survival of human being. After civilization, the food is being manufactured in a factory where the main challenge is to produce quality food products. The activity of food manufactures are to procure raw materials from different sources, processed, packaged and safely made it available for the end users i.e. consumers. One of the responsibilities of food manufacturer is to ensure safe food. This means that it is neither injurious to health nor unfit for human consumption. Now a day, food quality and safety has become a key issue in worldwide, public health agencies and governments of several countries look for more efficient ways to monitor production (Makiya and Rotondaro 2002) as well as supply chains. The World Health Organization (WHO) since its inception promoted food safety as unsafe food has great health and economic consequences. The conventional approach to ensuring food quality and safety, which totally depends on inspection as well as testing of final products. Further, conventional method has proved to be inadequate in controlling food-borne disease outbreaks.

The manufacture of a good food product is not sufficient but, it must be free from pathogens as well as harmful additives and remain maintained quality and safety for a period till it is consumed. So, in order to ensure quality and food safety programme various methods has to be employed within the food industry, will vary considerably in accuracy and

sophistication as per type of process, size and nature of resources available. Since the international market has become demanding in terms of quality, safety and delivery, installation of Hazard Analysis Critical Control Points (HACCP) in food industry would encourages a competitive environment to food supplies in national and international market. The HACCP system is adopted as an important tool in overall control of food borne diseases (FBDs). The International Commission on Microbiological Specifications for Foods (ICMSF), WHO, the *Codex Alimentarius*, and food regulatory agencies in various countries are recommending the implementation of HACCP system. 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 ensure maximize food safety in each step of the process (Cullor, 1997).

HACCP system, which identifies, evaluates, and controls hazards that are prominent for food safety. It can be applicable throughout the food chain from the initial production to final consumption. It not only enhances food safety but also better use of resources and timely response to problems. Due to that, HACCP system is now widely accepted by the food industries as well as government regulatory agencies around the world as a most cost effective means of maximum reduction and occurrence of identifiable food borne hazards i.e. biological, chemical and physical hazards and maximizing product safety. Further, this system targets areas of processing and ultimately, reduces the risk of manufacturing and selling unsafe products.

The primary objective of a HACCP programme is to provide reliable safe food among consumers. Industry is fairly familiar with various microbiological, chemical or physical hazards and trying to control different types of common hazards. In spite of, familiarity and knowledge of food poisoning derived from microbiological and chemical causes, or injury from glass, wire and other hazardous physical objects followed by their control is tedious and

occasionally, they induces serious consumer safety exposures and expensive product recalls and retrievals. It is therefore necessary to have technical orientation on common microbiological, chemical and physical hazards that may cause serious problems in food.

General Principles and Definitions

HACCP is a science based preventive system which systematically identifies specific hazards for production of safe food and provides measures for their control to ensure safety of food. In other words, it is a tool for assessing various hazards and establishing their control system that mainly emphasis on prevention rather than depending mainly on end product testing. It is based on technical as well as scientific principle which is applicable to every step of the food production chain and distribution systems, in order to make available safe food to consumer (ICMSF, 1991). A successful and effective implementation of the HACCP system requires the use of risk based decision making in identifying significant hazards at different points in the food processing chain and establishing critical limits at specified critical points.

HACCP systematic scientific analysis which identifies raw ingredients/materials and processed foods that may contain toxic substances, which are potential sources of contamination and agent of food borne diseases (FBD). Further, it may also determine the possibility of survival of microorganisms or grow during food production, processing, storage, and preparation (ICMSF, 1991). HACCP was first developed by Pillsbury Company, for astronaut of National Aeronautics and Space Administration (NASA) in the 1960s in order to ensure the safety of foods (Bauman, 1990). It was presented at the first US National Conference on Food protection and first applied to low acid canned foods (Jay, 2005), the HACCP has since been applied throughout the food industry to a large variety of products and to food service industry (Bryan, 1981; 1990a & 1990b). The following terms, concepts

and terminology are valuable in the development and execution of HACCP system (Cusato et al, 2012; ICMSF 1986):

- *Corrective action*: immediate and specific procedures to be followed whenever critical limits are not met.
- *Critical point:* any point in a specific food system where loss of control does not lead to an unacceptable health risk.
- *Critical control point (CCP)*: a place, practice, procedure, or process that may be controlled to prevent, eliminate, or minimize the hazard to acceptable levels.
- *Critical limit*: physical (time, temperature), chemical (pH, acidity), or biological (sensorial, microbiological) attribute or value determined for each CCP, which indicates that the operation is controlled.
- *Decision tree*: logical sequence of questions that enable the identification of a raw material, step in the process, or ingredient as a CCP.
- *Hazard*: any biological (growth or survival of microorganisms), chemical (pesticides, antibiotics, heavy metals, cleaning products), or physical (pieces of glass, metal, or other materials) contamination, rendering the food unfit for consumption.
- *Monitoring*: measurement of time/temperature, pH, or acidity, or supervision of CCPs in order to assess whether critical limits are met; if not, the CCP is not controlled and corrective actions are necessary.
- *Risk*: probability that the hazard will occur. Risk levels may be high, moderate, or low, and may vary according to the situation.
- *Severity*: magnitude of the hazard or of the consequences to the health of consumers. Diseases may be classified, in terms of severity, as lethal, chronic, or mild.

- *Verification*: additional tests and/or review of monitoring records in order to ensure whether the HACCP plan is working as designed. Verification may cause some of the steps of the process to be changed to ensure food safety.

The HACCP system has modified and developed over the years. The ICMSF published most detailed report on HACCP system and its basic principles (ICMSF, 1988).

Proper implementation of HACCP relaying on the understanding as well as correct application of these principles which were described by Mayes and Mortimore (2003) which are as follows:

1. Analysis of hazards and risk associated with the raw materials, ingredients, processing, distribution and consumption
2. Determine the CCPs to control the identified hazards using a decision tree, if necessary
3. Establish the critical limits for the preventive measures associated with each CCP
4. Establish procedures to monitor the CCPs
5. Establish corrective actions to be taken for deviations in critical limits
6. Establish effective record keeping system for every control
7. Establish procedures for verification

APPLICATION OF HACCP SYSTEM

The application of food safety management system consists of three distinct however interrelated phases namely prerequisites steps, preliminary steps and primary steps (Sohrab, 2001, 2002).

A. Prerequisites Programmes for Implementing HACCP

***Management commitment*:** The successful application of HACCP system depends upon totally on the top management group. So, it needs commitment followed by involvement of top management at different stages of development and implementation of the system. It can

happen when there is clear understanding of HACCP system. What benefits offer to the industry, what is really involved and what resources will be required from HACCP? The management should make its intended quality and safety which must be clear by defining its policy and should be responsible to:

- Approve and drive food safety management programme,
- Ensure that the programme continues to move forward and remains valid,
- Appoint a management representative and HACCP team,
- Ensure that adequate resources are made available to the HACCP team,
- Establish a progress monitoring and reporting procedure,
- Ensure that the programme goals are set which are realistic and achievable,
- Approve any changes to the food safety management programme.

***Empowerment of employees*:** The awareness training programme is one of the essential steps for successful quality as well as food safety management programme. Training not only provides the technical skills required in implementing HACCP but also helps in changing attitudes of people to appreciate the importance of food safety. It is essential to provide training through the hierarchy of the organization depending on the contribution of individuals in the successful implementation of HACCP. The extent and elaborative training varies depends on the degree of involvement of the personnel in pursuit of food safety in the food organization.

***Facility specific requirements*:** Besides management commitment and employee empowerment, the organization must have the following instead of representing International Code of General Principal of Food Hygiene as laid down by Codex Alimentarius Commission (Codex, 1997).

- Design and Facilities

- Personal hygiene
- Supplier control
- Specifications
- Machinery and equipment maintenance
- Cleaning and sanitation
- Chemical control
- Receiving storage and shipping
- Product recall programme
- Pest control programme
- Calibration of measuring devices

***Compliance to food laws*:** It is mandatory for the implementation of HACCP programmes to comply with the national food laws or the guidelines of given by Codex Alimentarius Commission for export of the foods outside the country. So food industries in India must follow the guidelines and provision of the Food Safety and Standard Authority of India (FSSAI) in order to create confidence among the consumers from different food hazards.

B. Preliminary Steps

Formation and Establishment of a multidisciplinary team

Development of HACCP based food safety management programme needs a multidisciplinary team with appropriate degree and expertise in different discipline like veterinary health, production, microbiology, toxicology, public health, dairy technology, food

technology, health, chemistry and engineering according to the particular study. This multidisciplinary functional expertise is must to adequately analyze all physical, chemical and biological hazards through the food chain. If in the team person are specialist in respective discipline and are not properly trained and experienced, HACCP system is not likely to be effective (Sohrab, 2000).

The team should have knowledge, experience and attributes to correctly as follows:

- Identify or recognize potential food hazards,
- Evaluate the existing system and data in a logical manner,
- Assign levels of severity and risk to identified hazards,
- Analyze problems and recommend controls, criteria and procedures for monitoring and verification to bring solutions to recurring problems,
- Recommend conducive corrective actions when deviations occur.
- Communicate both within the team and with people across all levels of the organization.
- Predict the success of the HACCP plan.

Describe the product

The food product (s) should include the major raw material, food ingredients, preservation and packing materials used and their affect or impact and food safety. In addition to this, it can also include a brief description of how the process occurs and/products are produced and stored. It would be quite useful when hazards exist either in ingredients or in packing material were identified. A description of the method of distribution includes type of transport and any special consideration in order to maintain product quality with safety. For example Ice cream is described as a frozen ready to eat product containing both pasteurized and unpasteurized components. The skim milk powder, butter, sugar and water

are pasteurized while the flavourings, nuts and chocolate are added without further heat processing. Air is also whipped into the product at freezing.

Identify Intended Use

The intended use should be based on the expected uses of the product by the end user or consumer. It should be properly informed or indicated how the product is to be used including if it is to be fully cooked before consumption, what preparations will be needed, what will be serving requirements, shelf life etc. In case of consumer has to taken special consideration such as infant or geriatrics it should be made clear so that necessary care and emphasis may be given to safeguard their special interest. For instance ice cream is consumed without further processing by general population high-risk groups but infant milk food is meant for infants and is given special consideration.

Construct a Process Flow Diagram

The HACCP team prepares elaborated process flow diagram (Fig-1) for each product informing critical steps of control. Each step within the specified area of operation is analyzed for the particular part of the operation under consideration in order to produce the flow diagram. While applying HACCP system to a given operation, consideration is given to steps preceding and following the specified operation. The process flow diagram is used as the basis of the hazards analysis and should therefore contain adequate technical know how for the study to progress. Each step within the specified area of operation should be carefully analyzed for the particular part of the operation under consideration to produce the flow diagram.

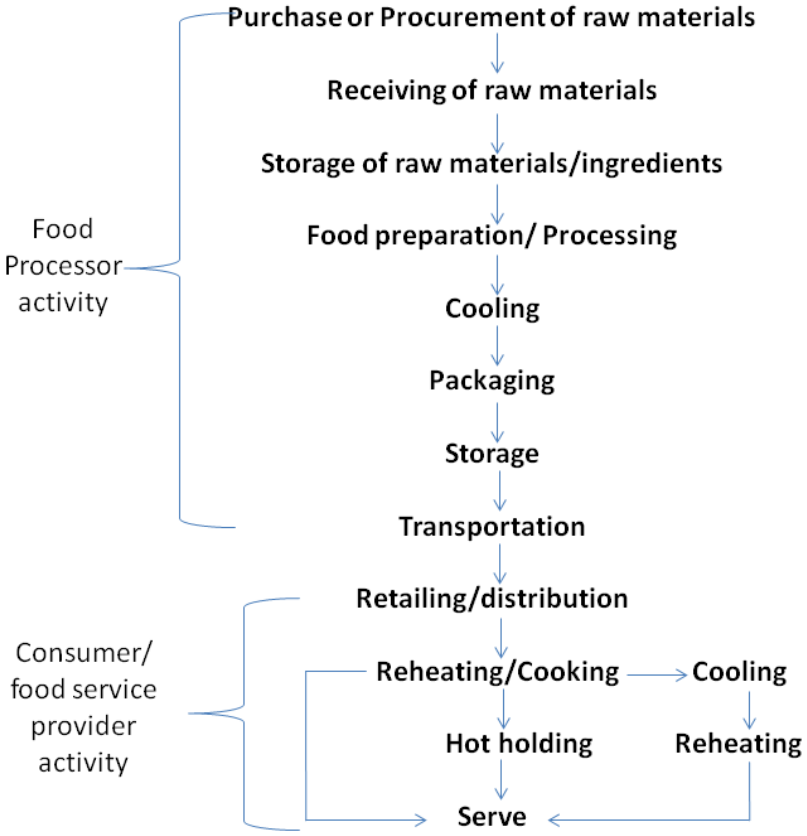

Fig. 1: Flow diagram of food supply chain

On-site Verification of Flow Diagram

The HACCP team at site to confirm the processing operation against the flow diagram during every stages and specified period of operation and modify the flow diagram where appropriate verifies the process flow diagram. This is partly on-site activity. Under the office exercise like dissecting the process stage and discussing the implications of process parameters and then they verified at the site. During visit of plant the accuracy and completeness has to be checked and make sure that the steps listed on the diagram describe what really occurs in producing the product does the verification of the flow diagram at site.

Such type of verification also consists plant layout verification because a poor layout may provide avenues for cross contamination from raw material to products, facilities to products and persons to products. This should also form part of on-site verification.

C. Primary Steps Based on HACCP Principles

Principle: 1 Conduct hazards analysis

After completion and verification process flow diagram and, the HACCP multidisciplinary team conducts a hazards analysis and lists all types of biological, chemical and physical hazards that may be reasonably expected to occur at each step from procurement of raw materials, primary production, processing, manufacture and distribution until the end user or point of consumption. During the hazard analysis, consideration must be given to the impact of raw material, ingredients, manufacturing practices, role of manufacturing processes in order to control hazards, likely end use of the product, consumer populations at risk and epidemiological evidence with respect to food safety. Subsequently, the team should identify in the HACCP plan which hazards are of such nature that their elimination or reduction to acceptable levels is essential to the production of safe food.

The common hazards found in food chain system are:–

Biological hazards	**Physical hazards**	**Chemical hazards**
Bacteria and their toxins	Glass	Natural plant and animal toxins
Parasites	Stones	Drug residue
Viruses	Bone and metal fragments	Cleaning compounds
	Packaging materials	Food additives
	Jewellery	Insecticides

Further, the team must consider what preventative measures, if any, exist which can be applied for each hazard. Preventative measures are those actions and activities that are necessary to eliminate hazards or reduce their impact or occurrence to acceptable levels so that any type of hazards can be controlled. More than one preventative measure may be required to control a specific hazard(s) and more than one hazard may be controlled by a specified preventative measure.

Principle: 2 Identify the critical control points

Critical control point (CCP) may be defined as a point/step/procedure where a food safety hazard can be prevented, eliminated or reduced to acceptable levels. Under the HACCP system, the identification of a CCP is facilitated by the application of a logical decision tree. All types of hazards that may be reasonably expected to happen, at each step, should be considered. If a hazard has been identified at a step where control is necessary for safety and no preventative measure exist at that step, or any other, then the product or process should be amended at that step, or at any stage, to include a preventative measure. The proper application of the decision tree determines whether the step is a CCP for the identified hazard.

Principle: 3. Establish critical limits for each CCP

The critical control points define the ranges between safe and unsafe products, it is vital that they are specified at the correct levels and validated at each criteria. The multidisciplinary HACCP team should therefore clearly understand the governing safety at each CCP in order to set the appropriate critical limits. The critical limits are essential to specify for each preventative measure. In few cases more than one critical limit will be

elaborated at a particular step. The criteria often using measurements of temperature time, moisture level, pH, and available chlorine, and sensory parameters such as visual appearance and texture.

Principle: 4. Establish a monitoring system for each CCP

Monitoring is one of the most considerable aspects of the HACCP system. It is the scheduled measurement of CCP with respect to its critical limits. The monitoring procedures must be capable to detect loss of control at the CCP and provide information in time for corrective action to regain control of the process. A designated person with knowledge and authority to follow up corrective actions when indicated must evaluate data derived from monitoring. If monitoring is not continuous, then the frequency of monitoring must be adequate in order to ensure that the CCP is under control. In most of the monitoring procedures for CCPs will need to be done analytical testing. Physical and chemical measurements are often preferred to 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 responsible reviewing official(s) of the organizations.

Principle: 5. Establish corrective actions

In the HACCP system, the specific corrective actions must be developed for each CCP 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 nonconforming product. In the HACCP record keeping, deviation and product disposition procedures must be carefully documented. Corrective action should also occur when monitoring results indicated a trend towards loss of control at a CCP. Action should be taken to bring the process back into control before the deviation shift towards to a safety hazard.

Principle: 6. Establish verification procedures

The HACCP system should consist of the verification procedures to provide assurance that HACCP system is being complied with on day to day basis. By using audit method, it can be done most effectively. Monitoring and auditing methods, procedures and tests, including random sampling and analysis, can be used to determine if the HACCP system is working properly. The frequency of verification should be sufficient to confirm that the HACCP system is working effectively. Verification activities include review of the HACCP system and its records, review of deviations and product dispositions, confirmation if caps are under control and validation of established critical limits.

Principal: 7. Establish record keeping and documentation

Efficient and accurate record keeping is one of the essential steps for successful application of a HACCP system. Records must be kept of all concern areas, which are critical to product safety to demonstrate that the HACCP system is in compliance with the documented system. The documentation of HACCP procedures at every step should be included and assembled in a manual. Records are useful in providing a basis for analysis of trends and internal investigation of any food safety incidents, which may occur. It is highly useful to allocate a unique reference number to each HACCP record.

The types of records that might be retained are as follows:

a) HACCP plan,

b) Modification to HACCP plan,

c) CCP monitoring,

d) Deviations and associated corrective action records,

e) Training records and

f) Audit records.

Conclusion

The HACCP system is a well accepted programme for food safety. This system really successfully works in practice will depend on the competency of people who responsible for it *i.e*, who developed and who operate it and prerequisite work, which support it. Integrated approach to implementation of ISO 9000 and HACCP is vital for management of quality and safety of food products to assure consumers not only in India, but throughout the world. Proper planning, training, commitment are some factors which are the affect the successfully implementation of this system in food industry. The regulatory agencies lay more emphasis on safety, while businesses emphasize on both quality and safety as component of reliable quality. HACCP adds reliability to quality i.e. food is not only good at the point of manufacture but also through its shelf life period.

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