The HACCP System - An Ideal Food Safety System

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Over a period of time there has been considerable change in the concept of fish processing. The modern seafood processing industry is very much sophisticated and technologically advanced. Further, several ingredients are now added to seafoods as additives, antioxidants, preservatives, emulsifiers, cryoprotectants and colouring materials. There are also problems of pesticide residues, toxic metals, mycotoxins, biotoxins, antibiotic residues and the like. Under these circumstances, the responsibility of the processor has become increasingly complex and hence, there is a global shift from food quality to food safety. This has resulted in the development of a safety-oriented quality system, the Hazard Analysis Critical Control Point (HACCP) System. This is a worldwide systematic and preventive approach that addresses physical, chemical and biological hazards through anticipation and prevention rather than through end-product inspection testing. The HACCP system consists of seven principles which are implemented in twelve steps. Advantages of the system are highlighted and the current problems in the implementation of the HACCP system are discussed in this paper.

HACCP is a worldwide-recognized systematic and preventive approach that addresses physical, chemical and biological hazards through anticipation and prevention rather than end product inspection and testing. The HACCP concept was pioneered in the 1960s by the Pillsbury Company, the United States Army and the United States National Aeronautics and Space Administration (NASA) as a collaborative development for the production of safe foods for the US Space Programme. In 1985, the US National Academy of Science recommended that the HACCP system could be adopted by the food industry to ensure food safety. Later, the International Commission on Microbiological Specifications for Food and the International Association of Milk, Food and Environmental Sanitations also recommended HACCP for food safety.

Advantages of HACCP

The HACCP food safety management system uses the approach of controlling critical points in food handling to prevent food safety problems. The system which is science based identifies specific hazards and takes measures for their control. HACCP is based on prevention and reduces reliance on end-product inspection and testing. The system can be applied in the food industry from 'farm to fork'. It enhances responsibility and degree on control at the level of food industry. Implementing HACCP does not mean undoing the quality assurance procedures or good manufacturing practices already established by the company; it only requires a revision and appropriate integration with the HACCP system. Further, the HACCP system can aid inspection by the regulatory authorities and promote international trade by increasing buyers' confidence. The HACCP system should be capable of accommodating advances in equipment design, process and technology.

Application of HACCP

To apply HACCP system in any food industry sector, the sector should be operating according to the Codex General Principles of food hygiene and appropriate food safety legislation. Management

Commitment is essential for effective implementation of HACCP system. The HACCP system works on seven principles and there are 12 steps in the implementation of HACCP. The original sequence for the application of HACCP system is shown in Fig. 1.

Assemble HACCP team

The first step in the application of HACCP is to assemble a team having knowledge and expertise to develop an HACCP plan. The Team should be multidisciplinary and should include plant personnel from production, sanitation, quality assurance laboratory, engineering and inspection. It is essential to assemble the right blend of expertise and experience as the team will collect and evaluate technical data and identify hazards and critical control points. If needed, advice of an external consultant can be obtained.

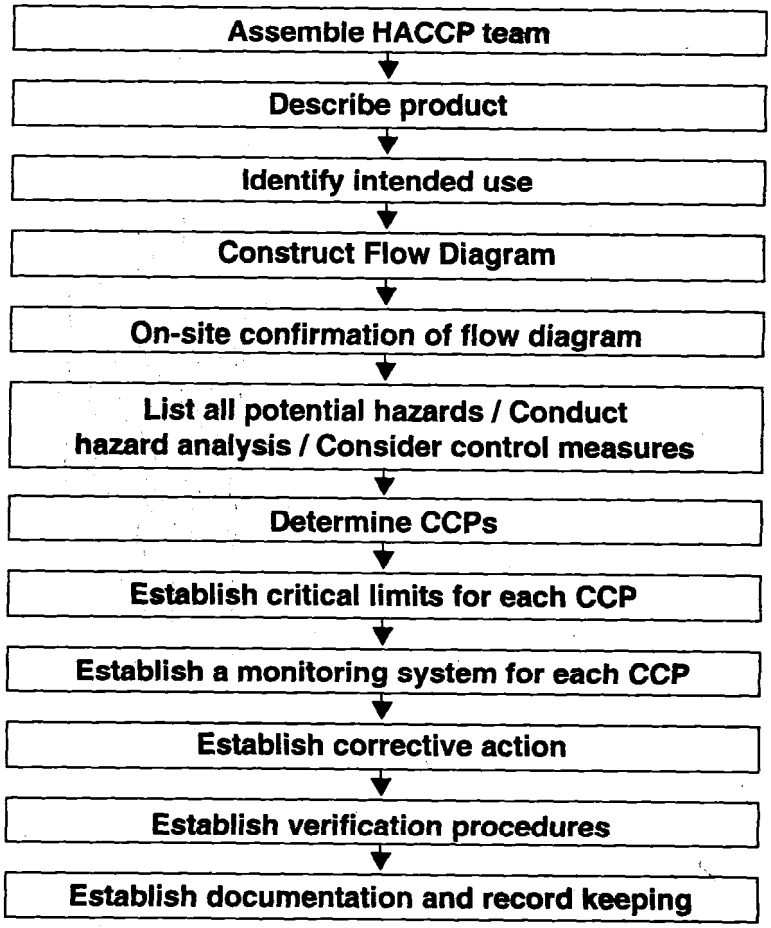

Fig. 1: Logic sequence for application of HACCP

Describe product

A full description of the product should be drawn up such as composition, physical/chemical structure (including a pH etc.), packaging, shelf life, storage conditions and method of distribution.

Identify intended use

Intended use of the product refers to its

normal use by end-users or consumers. The HACCP team must specify where the product will be sold and the target group especially if it happens to be a sensitive group (elderly, infants, immuno-suppressed and pregnant women).

Construct of flow diagram

It is easier to identify the potential routes of contamination and to suggest control measurers if there is a flow diagram. The critical control points can also be easily identified. The process flow diagram should identify all the important steps from receipt of raw material to final shipping. Details like ingredients and packaging materials used, time-temperature history, flow conditions, product recycle, equipment design etc. should get reflected in the flow diagram.

On-site confirmation of flow diagram

Once the flow diagram has been completed it should be confirmed by on-site inspection for accuracy and completeness. It will also confirm the assumption with respect to the movement of product and employees on the premises.

Hazard analysis

Hazard analysis is the first step of HACCP principle. As is evident from the title, this step is the most important in the HACCP system. Any mistake in hazard analysis will lead to inadequate HACCP plan. Hazard analysis requires technical expertise and scientific background in various aspects of food science and technology for proper identification of all potential hazards. In the HACCP plan, hazard analysis is essential to identify which hazards are of such a nature that their elimination or reduction to acceptable level is essential for production of a safe food. Hazards will vary among firms making the same product because of difference in (i) sources of ingredients, (ii) formulations, (iii) processing equipments, (iv) process/ preparation methods, (v) duration of processes, (vi) storage conditions, (vii) experience/knowledge of personnel and (vii attitude of food-handlers.

Hazard analysis is to be conducted for all existing and new products. Whenever there is a change in raw materials, product formulations, processing procedures, packaging, distribution and use of the product, the original hazard analysis is to be reviewed. In conducting hazard analysis the following points are to be considered:

i) The likely occurrence of the hazard, its severity and adverse effects on health

ii) Survival and multiplication microorganisms

iii) Production and viability of toxins

iv) Production of chemicals and condition leading to their production

Hazards are classified as physical, chemical and biological (Table 1). After hazard analysis is completed, the team must consider what control measurer can be applied for the control of each hazard. Control measures are actions that can be used to prevent or eliminate a food safety hazard or to reduce it to an acceptable level. More than one measure may be required to control a specific hazard or more than one hazard may be controlled by a specific measure.

Table 1: Physical, Chemical and Biological hazards in food products:

Physical hazards	
Glass	Insulation
Wood	Bone
Stones	Plastic
Metal	Personal effects

Chemical hazards		
Normally occurring chemicals	**Added chemicals**	**From packaging materials**
Allergens	Pesticides	Vinyl chloride
Aflatoxins	Fertilizers	Printing inks
Mushroom toxins	Antibiotics	Adhesives
PSP	Growth hormones	Lead
DSP	Lead	Tin
ASP	Zinc	
Ciguatoxin	Cadmium	
	Arsenic	
	Food Additives	
	Contaminants such as: Lubricants, detergents, sanitizers, paints and refrigerants.	

Biological hazards		
Bacteria (Spore forming)	**Bacteria (Non-spore forming)**	**Virus, protozoa and parasites**
Clostridium botulinum	Salmonella	Hepatitis A and E
Clostridium perfringens	Shigella	Rotavirus
Bacillus cereus	*S.aureus*	*Taenia solium*
	V. parahaemolyticus	*Taenia saginata*
	V. vulnificus	*Entamoeba histolytica*
	V. cholerae	
	L. monocytogenes	

Determine Critical Control Points

This is the second principle of HACCP. It is a step at which control can be applied and it is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level. If a hazard has been identified at a step where control is necessary for safety and if no control measure exists at that step or any other, then the product or process should be modified at that step, at an earlier step or at a later step to include a control measure. Determination of CCPs in the HACCP system can be facilitated by the application of a decision tree. In a processing system, CCP is the point where hazards need to be prevented, eliminated or reduced to acceptable levels. For example, time-temperature monitoring is a CCP in a cooking line, where a particular temperature for a particular period will destroy all microorganisms. Similarly refrigeration to prevent hazardous microorganisms. pH measurement to prevent bacterial growth and metal detector on the packaging line can be considered as Critical Control Points.

Establish critical limits for each CCP

Critical limits are criteria that separate acceptability from unacceptability. In other words, critical limits are boundaries used to judge whether a safe product is being produced. Critical limits can be set for parameters like temperature, time, pH, a_w, moisture level etc. Critical limits could meet

government regulations, company's standards and should be supported by scientific data. Source of information on critical limits can be obtained from scientific publications, Government regulations, experts and experimental studies. If the required information on critical limits is not available, a conservative value should be selected. The reference material used should be recorded and this should become part of the support documents for the HACCP plan.

Establish monitoring system for each CCP

Is the act of conducting a planned sequence of observations of control parameters to assess whether the CCP is under control. Monitoring procedures should be efficient enough to detect loss of control at the CCP. It is important to specify how, when and by whom monitoring is to be performed. There are several ways to monitor the critical limits at the CCPs. It can be done continuously or on batch basis. Continuous monitoring is preferred as it is possible to identify shifts around the critical limits. When monitoring is not continuous, the frequency of monitoring should be specified. Monitoring procedures should be rapid. Physical and chemical measurements and visual observations are preferred to microbiological methods. pH, a_w, moisture, time, temperature are usual parameters tested. It is essential that all the monitoring equipments are calibrated for accuracy.

Establish corrective action

Corrective action is the action to be taken when the results of monitoring at the CCP indicate a loss of control. Loss of control will result in a deviation from the critical limits for a CCP. Corrective action should then be taken following any deviation to ensure safety. If the corrective action does not address the root cause of the deviation, then the deviation could recur. Corrective action steps include (i) investigation to determine the cause of deviation, (ii) effective measure to prevent recurrence in future and (iii) verification of the effectiveness of the corrective action taken.

Establish verification procedures

Verification procedures are necessary to assess the effectiveness of the HACCP plan. Periodic verification helps to improve the HACCP plan by exposing weaknesses in the system and eliminating unnecessary or ineffective control measures. Verification activities include (i) HACCP plan verification, (ii) HACCP system audit, (iii) equipment calibration and (iv) targeted sample collection and testing.

Establish documentation and record keeping

Record shows process history, monitoring, deviations and corrective action including disposition of product that occurred at the identified CCP. Records may be in the form of chart, written record and computerized record. Four types of records, viz. (i) support documents for developing HACCP plan, (ii) records generated by the HACCP system, (iii) documentation of methods and procedures, (iv) records of employee training programmes are to be maintained.

Requirements for a successful HACCP system are (i) committed management (ii) plant design as per GMP, (iii) insect and pest control (iv) hygiene and sanitation and (v) trained personnel. Current problems in its implementation are lack of verification, evaluation, validation, review and audit and that it is not applied from "farm to fork". HACCP is not a sophisticated system requiring high technology and highly educated staff. Simple tests like sensory methods, time-temperature evaluation, pH determination etc., are employed in this system. The system can be run by the technical staff of the industry after they get adequately trained under an expert.