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Hazard Analysis Critical Control Point Concept in Seafood Industry

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Hazard Analysis Critical Control Point (HACCP) is a total quality management system with stress on safety. It is a management tool that provides a structural approach to identify and control hazards. In food processing industry HACCP plan is developed by applying seven principles. These principles are discussed in this paper. The paper gives sufficient stress on the pre-requisite programmes, standard operational procedures, sanitation and defect action plans. Models of raw material check list and HACCP analysis for IQF shrimp preocessing are also presented.

Key words: Hazard analysis, critical control points, monitoring, documentation

World over, the food processing industry is shifting towards Hazard Analysis Critical Control Point (HACCP) system of quality management. This is a total quality management system with stress on safety based on a systematic approach to hazard identification, assessment and control which makes it different from the traditional inspection and quality control procedures. In HACCP system control is transferred from end product testing to on-line checking, that is a change from 'testing for failure' to 'preventing failure'. In 1973, the USFDA adopted HACCP for inspection of low acid canned food processing plants to prevent *Clostridium botulinum* contamination. In 1975 it was adopted for inspection of meat processing plants. In 1980 WHO/ICMSF (International Commission on Microbiological Specification of Foods) recommended HACCP for food safety in developing countries. European Commission (EC) has made HACCP based quality management systems mandatory in fisheries to export shrimp/ fish products to European Market. Such systems are recommended by the USFDA for countries exporting seafood to the USA.

HACCP Concept

Fig. 1 presents the seven principles of HACCP (Codex, 1991). The system envisages identification of potential hazards in seafood processing at all stages upto the point of consumption. A detailed flow chart of the process covering all aspects from the point of catch through various pre-processing and processing activities will help in identifying the potential hazards and establish the conditions necessary to control the hazards. Based on this, suitable remedial measures should be specified. The various steps involved in the control measures are listed in the system.

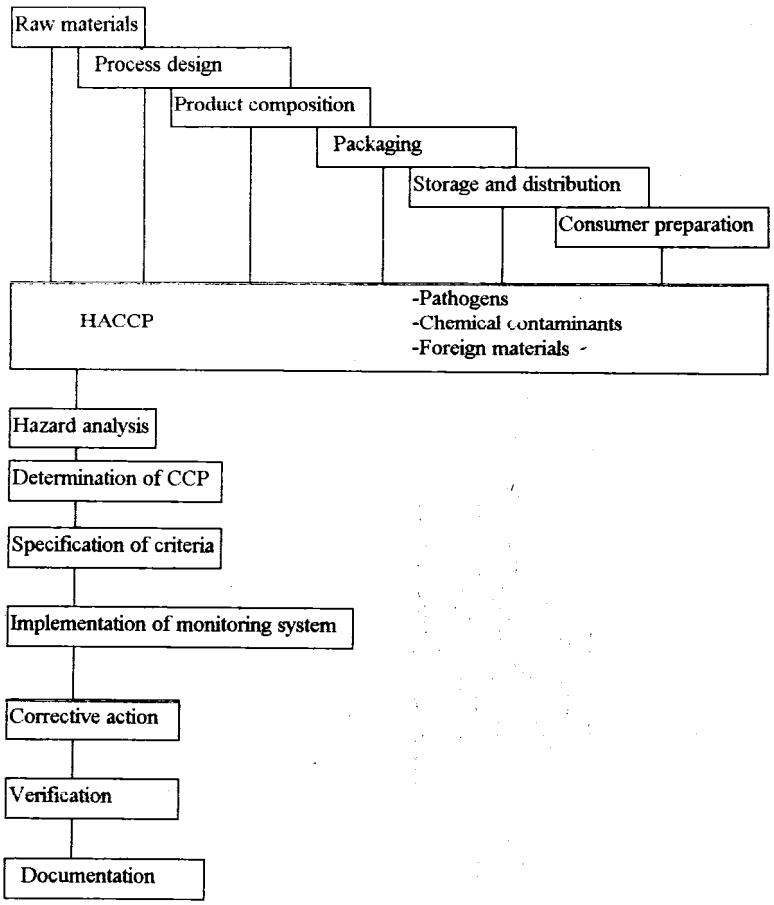

Fig. 1. HACCP concepts and its seven principles

Prerequisite Programmes

Some prerequisite programmes detailed below, though may be not directly related to manufacturing controls but support the HACCP, have to be developed, documented and implemented.

- Premises: Land, building, hygiene facilities, water quality
- Receiving/storage of raw materials, ingredients and packaging materials
- Equipment performance and maintenance including design and installation
- Personnel training on manufacturing controls and hygienic practices
- Employee hygiene, sanitation and pest control programmes.

- Health and safety recalls: Product identification and coding, recall system
- Labelling to meet the requirements of the target market.

If any portion of a prerequisite programme is not adequately controlled, then additional CCPs would have to be identified, monitored and maintained.

Standard Operating Procedures (SOPs)

All operations from reception of raw materials to shipment of finished product should be standardised, documented and strictly followed. These are called SOP. Formats are required for raw material checklist, calibration log, engineering log (production) for entering cooker temperature, chill water temperature and freezer temperature, chlorination log, quality of the finished product, quality of packaging materials, cold store log, shipment log etc. A model raw material checklist is presented in Table 1.

Table 1. Model raw material checklist

Date :
Variety :
Batch No. :
Crate No. :
Location :

Parameters	Pass/Fail	Comments	Corrections made
1. Cleanliness of the truck			
2. Cleanliness of the crates			
3. Icing			
4. Temperature of raw material			
5. Count			
6. Uniformity			
7. Discolouration			
8. Black tail			
9. Black spot			
10. Soft shell			
11. Odour			
12. Texture			
13. Extraneous matter			

Sanitation Standard Operating Procedures (SSOPs)

A model SSOP has been prescribed by MPEDA (1977). The areas where SSOP has to be put into operation, the schedules and systems for monitoring them and its periodicity have been dealt with in detail. The areas covered are sanitary aspects of water and, food contact surfaces including equipment, machinery, utensils and employees; cross contamination with potable and non-potable water, materials at different stages, ice, utensils etc; pest control measures; sanitising and toilet facilities;

protection from adulterants; storage of toxic chemicals and employee health. The areas where monitoring of sanitation on a daily basis is essential have been identified and a daily sanitation audit form has been prescribed.

Defect Action Points (DAP)

Defect Action Points are steps or procedures applied during processing to ensure compliance with regulations in force. DAP could be determined through a "Regulatory Hazard Analysis" which will identify the regulatory requirements for specific products and processes.

HACCP Plan

HACCP plan is the written document that defines and describes the procedures to be followed for ensuring the safety of a product or process. It is developed by applying the seven principles of HACCP. HACCP plan should be established for every product and process. Thus, if there are three different product lines in one plant, three HACCP plans have to be developed.

HACCP Study

A logic sequence for the application of HACCP is given in Fig. 2 (Anon, 1996). The seven principles of HACCP are applied in these stages. The first step is assembling an HACCP team. The team should consist of experts from a wide range of disciplines with knowledge in the specific product. In fish processing, they should include experts in biology, production technology, quality control, hygiene, microbiology, packaging, plant maintenance, marketing and the related aspects.

The team must examine the product and identify its characteristics and ways in which it is used. They should specify the nature of the product, its physical characteristics, processing methods, packaging, storage, shelf life, distribution, instructions for use, microbiological/chemical criteria, intended use, target consumer and customer specifications. Finally they should develop a detailed flow chart supported by full technical data on site plan, plant layout, sequence of operations and their time schedule, packaging and storage, flow of materials with particular reference to possibility of cross contamination, identification and demarcation of risk areas, and personnel and environmental hygiene. This flow diagram is a tool to identify hazards and establish critical control points.

Hazard

A hazard is a biological, chemical or physical factor with potential to cause an adverse effect on health. The HACCP team should list all hazards that may be reasonably expected to occur at each step from production to consumption.

Biological hazards include pathogenic microbes, viruses, parasites, toxigenic plants, animals and products of decomposition like histamine. Chemical hazards include pesticides, cleaning compounds, antibiotics, heavy metals and, food colours and additives other than permitted ones. Extraneous matter like filth, bones, metal fragments, glass, stones etc. are the physical hazards.

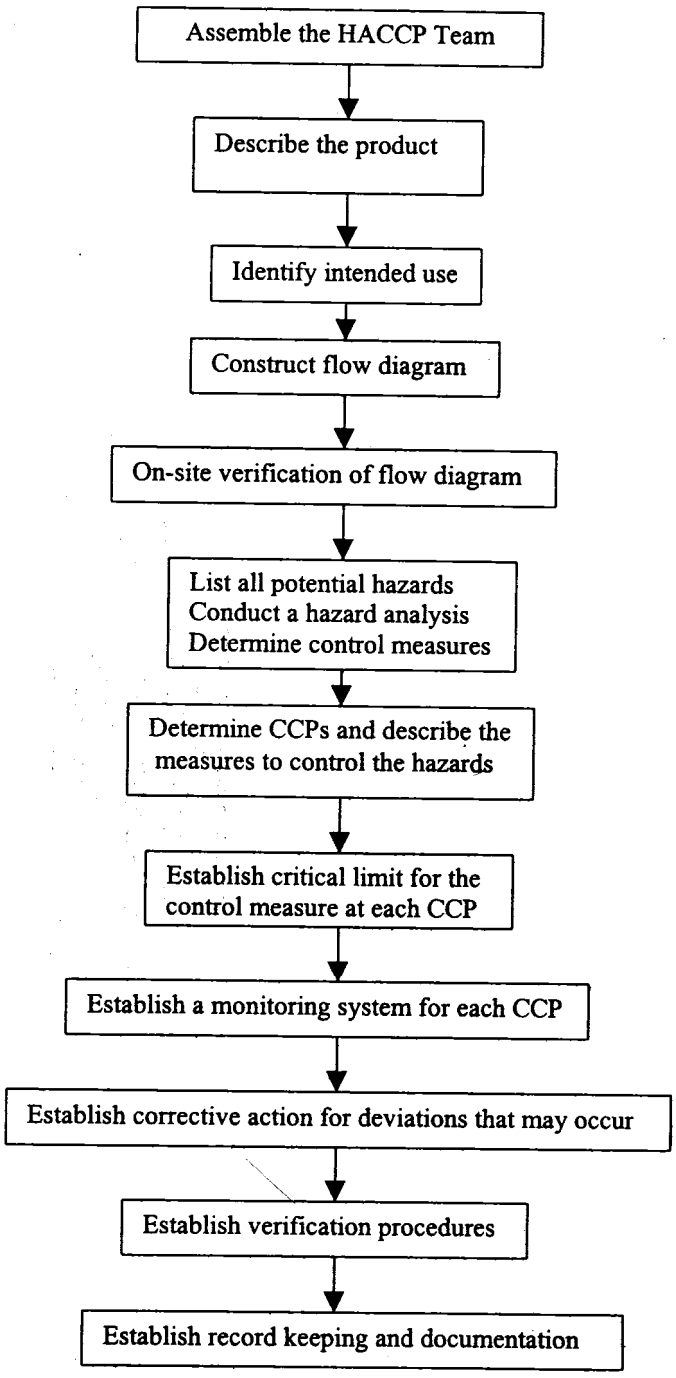

Fig. 2. Logic sequence for the application of HACCP

Hazard Analysis

Hazard analysis is a system used to analyse the significance of a hazard for consumer safety. It should decide which hazards are of such nature that their elimination or reduction to acceptable levels is essential to produce safe food. A model HACCP analysis for IQF shrimp production is given in Table 2.

Table 2. HACCP Analysis of IQF shrimp production

Process step	Hazard	Control measure	Critical limit	Monitoring procedure	Corrective action
Capture & landing	Spoilage, contamination, pathogens	Cleaning schedules icing, hygiene	Time lag between capture and landing, before and after icing	Visual inspection recording of time delays	
Chilling	Decomposition, contamination	Adequate icing, container cleaning, potable water	Ice to shrimp ratio, potable water for ice, temperature 0-3°C	Visual inspection, checking of ice quality	
Transport	Decomposition, contamination	Adequate icing, vehicle cleaning, potable water	Ice to shrimp ratio, cleaning schedule, ice from potable water	Visual inspection, checking ice quality/vehicles	
Reception	Decomposition, contamination: physical/bacterial	Adequate icing, cleaning schedules	Temperature 0-3°C, cleaning schedules	Temperature monitoring, work surface check	
Washing	Contamination, microbial growth	Cleaning of tanks, potable chilled water	Daily cleaning of tanks, water at 0-3°C, time delays	Monitoring of temperature and time delays	
Grading/ Sorting	Contamination, spoilage	Cleaning/sanitizing, training, hygiene, product movement	Temperature below 10°C, grade specified, hygiene	Temperature monitoring checking grades.	
Peeling	Contamination: spoilage, physical and bacterial	Cleaning, personal hygiene, product movement	Adherence to cleaning schedule, personal hygiene	Sampling, checking	
Washing	Contaminated water, microbial growth	Cleaning of tanks, potable chilled water	Tanks cleaned daily. Water held at 0-3°C, time delays	Monitoring of temperature and time delays	
Chilling	Decomposition, contamination	Cleaning air filters, equipment, control of temperature	Regular changing of air filters	Monitoring temperature and filter changes	
IQF	Contamination: physical and bacterial	Periodic cleaning, training	Adherence to cleaning schedule & temperature -40°C.	Monitoring of temperature	
Glazing	Microbial contamination	Water/ice quality, temperature control, training	Glazing limits, potable water, cleaning schedule	Laboratory checks, periodic bacterial checks	
Packing, coding, master cartoning	Microbial growth	Personal hygiene, training, equipment calibration, metal detectors, control of temperature	Correct weight, zero tolerance of metal, proper coding	Regular checks metal detector checks daily	

Identification of hazards

Food borne illness traced to consumption of a particular product is evidence that an uncontrolled hazard exists. The root cause of the illness should be identified by subjecting the food to detailed analysis. After identifying the type and nature of contamination the stage at which it might have occurred, either during or after processing, should be ascertained. It must be established whether they are completely eliminated or brought down to safe levels. Principles in identifying potentially hazardous micro-organisms have been described by Notermans *et. al.* (1994).

Assessment of hazard

The analysis of hazards must be quantitative to provide useful information. This requires the assessment of two factors, risk and severity, with respect to any identified hazard. Risk expresses the chance of a hazard occurring. The severity of the hazard is related to its magnitude. An "unacceptable health risk" is the risk that exceeds the regulatory action levels, tolerances, or other limits established for the hazard. The HACCP team has the responsibility to decide which hazards are significant and must be addressed in the HACCP plan.

Identification of control measures

After assessing the hazard the team must consider the existing control measures which can be applied for each hazard. More than one control measure may be required to control a specific hazard and more than one hazard may be controlled by a specific control measure.

Time/temperature control, fermentation, pH, addition of salt or other preservatives, drying, raw material source etc. are the various measures to control biological hazards. Chemical hazards can be prevented by controlling raw material quality, production process and use of food additives. Physical hazards can be controlled by using metal detectors, UV light etc.

Determination of Critical Control Points (CCP)

A critical control point is a step or procedure that can be applied to prevent or eliminate or to reduce hazard to an acceptable level. In some processes a single operation at a CCP can completely eliminate one or more hazards. Such a point is designated CCP1. CCP2 will minimise but will not assure complete control of the hazard. Both are important in food applications. If a hazard can be controlled at more than one point, the most effective point must be identified. Many methods are available to determine CCP in a system (Notermans *et. al.*, 1994). A decision tree has been described for identification of the critical control points (Anon, 1994).

Critical Limits

A critical limit is a criterion, which distinguishes acceptability from nonacceptability. These criteria, if maintained within limits, will confirm safety of the product. A critical limit must be specified for each control measure at each CCP. In some cases more than one critical limit will be specified at a particular CCP. Criteria often used include

temperature, time, moisture, pH, water activity, chlorine level, sensory parameters etc. Examples of critical limits at the following CCP are:

Receipt of raw/frozen shrimp	:	Maximum 100 ppm sulpites
Cooked shrimp (cooker)	:	Cook at 100°C for 3 minutes
Dried shrimp (dryer)	:	Water activity 0.70 or less
Tuna butchering	:	Histamine < 50 ppm, Fish temperature 0-5°C

Critical limits may be derived from government regulations and guidelines, international codes of practice, literature survey, experimental studies and/or through advice of experts. It should be ensured that the critical limit(s) will control the identified hazard before the HACCP system is finalised and implemented.

Monitoring and Checking System

A system to monitor, check and measure specific critical limits at each CCP is very essential. The programme must clearly describe who will perform monitoring, when and how. Monitoring should be rapid so that corrective actions can be taken in time. Main methods of monitoring are sensory evaluation, physical measurement and chemical testing. Microbiological testing is of limited use in monitoring CCP. It can be employed for testing raw materials before starting processing, and for testing finished products before release.

Corrective Action

When deviations from critical limits are noticed, corrective actions must be taken immediately. Hence a plan must be prepared and implemented in advance so that there will be no delay in taking corrective action. The plan should be developed by the HACCP team specifying the corrective action, identifying the persons to take the action, disposal of the product processed during the 'out of control' period and documentation of corrective action.

Verification and Review

The HACCP team should describe in detail the methods and procedures used to verify the system. Examples of methods used for verification are:

- Random sampling and analysis (microbiological) and trend analysis.
- Detailed tests at selected CCP.
- Intensified analysis of intermediate or final products.
- Survey of conditions during storage, distribution, sale and use of products.

Verification procedures include inspection of operations, validation of critical limits in consultation with specialists, experts and standards organisations, review of deviations from the set critical limits and corrective actions and audit of the entire HACCP system and its records by on-site observations and record review. Verification may be done by plant management or by external agencies or in collaboration with Government agencies. If any revision is needed it must be implemented and the

changes must be fully integrated into all written documents and the record keeping system.

Documentation

Proper records should be maintained on all actions in the HACCP system in order to trace the origin, cause and point of occurrence of the hazard (Anon 1996). Records are required to be maintained on the following.

- HACCP plan and support documentation.
- Monitoring of critical control points
- Records of corrective action
- Records of verification activities and modifications
- Nature, coding and disposition of the product

Conclusion

HACCP is not a sophisticated system requiring high technology and highly educated staff (Skoogaard, 1991). Simple methods 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 adequate training under an expert in this field. Documentation in each and every step is the most important aspect of HACCP.

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