## Chapter 32

# HACCP - A preventive strategy

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Food-borne diseases, i.e. illnesses due to consumption of contaminated foodare one of the most prevalent health problem in India as well as in other parts of the world. (WHO, 1984). In spite of efforts taken, food-borne diseases are increasing in number and frequency all over the world. This problem is likely tc continue to grow, unless new methods and strategies are adopted to counter them (WHO, 1991). This feature can be attributed to the insufficiency of the traditional approaches of quality control in controlling and preventing food-borne diseases. Hence, it is imperative that a concerted approach to food safer be developed. World Health Organisation's suggestion for this is to combine an effective food safety infrastructure with an adequate educational programme (WHO, 1991). This could be achieved by combining two types of information. The information on the socio-cultural and economic situation and (ii) the technical information related to food manufacture and food habits obtained through the application of the Hazard Analysis and Critical Control Point orHACCP (WHO, 1993).

HACCP is a rational method, increasingly adopted by food manufacturers throughout the world for the prevention of food-borne diseases (WHO, 1993).Itis a system of controls in a food processing industry, which helps them to identify and prevent problems even before they occur. This system is systematic an': scientifically based and is considered as a tool for ensuring food safety throughoutthe world (Brian, 1992).

Even though HACCP was introduced in food system as early as 1960's, it found its way in India only recently. Interestingly among the various food processing activities, this system was initially introduced in the fish processing sector. This changeover is rather forced upon the seafood processors because of the emergence of the European Union Market, which contributes to more than 40% of the total export market of marine products from India.

WHO defined HACCP as a `Systematic approach to the identification and assessment of the hazards and risks associated with a food operation

and defining of the means of their control' (WHO, 1993). Any thing which has the potential to cause harm to consumer safety should be considered a hazard.

World Health Organisation and International Commission of Microbiological specification of Foods recommended HACCP for food safety in developing countries (WHO/ICMSF, 1980). European Commission (European Commission 1991 and 1994)has made HACCP based quality management system mandatory in fisheries to export shrimp/fish products to European markets. Such systems are recommended by ISFDA for countries exporting seafood to USA. the Codex Alimentarius Commission is currently encouraging practical implementation of HACCP systems in food industries (Codex, 1991). Recent legislation from the EC (European Commission, 1991 and 1994)also requires the use of HACCP – based quality management systems in countries wishing to export shrimp products to the single european market fro the start of 1993. HACCP based quality management systems are also advocated in the USFDA/NOAA Voluntary Seafood Inspection Programme and will be required from early 1998 by the USFDA for countries exporting seafoods to the USA.

**HACCP an overview**

HACCP is a management tool that provides a more structured approach to the control of identified hazards that that available by traditional inspection and quality control procedure. When applying the HACCP concept in food processing, control is transferred solely from end product testing |(i.e. testing for failure). There will, however, always be a need for some end product testing particularly for verification purposes and in product development.

The process variables that are used to control the operation are identified by a HACCP review. Much of the effectiveness of HACCP is achieved through the use of a multi-disciplinary team of experts. The team should have members from relevant area, e.g. microbiology, food chemistry, production, quality assurance, food technology and food engineering. HACCP involves the identification and analysis of hazards associated with all stages of food processing chemical and physical hazards should be all considered if they affect production safety. Following hazards analysis, Critical Control Points (CCPs) are identified with appropriate measures which can be applied to control each hazard. Finally, monitoring and verification systems are put in place to ensure that the HACCP is working.

The benefits from the use of HACCP are many and can be summarized as follows (Anon, 1996):

- HACCP is a systematic approach covering all aspects of food safety from raw materials, growth, harvesting and purchase to final product use.
- Use of HACCP will move a company from sole retrospective end product testing approach towards a preventive quality assurance approach.
- HACCP provides for a cost-effective control of food borne hazards
- Use of HACCP focuses technical resources into critical parts of seafood processing.
- The use of preventive approaches such as HACCP leads to reduced product losses.
- International bodies recommend HACCP as the most effective means for controlling food-borne diseases.
- Demonstrating that a HACCP quality management system is in place in processing plant will assist in meeting standards in importing countries and contribute to customer satisfaction.

**Principles of HACCP**

HACCP is a powerful system which can be applied to a wide range of simple and complex operations. For food processors to implement HACCP they must investigate not only their own product and production methods, but must also apply HACCP to their raw material supplies and to final product storage must consider distribution and retail operations up to and including the point of consumption. The HACCP system consists of the following basic principles(Codex, 1991):

Principle 1: Conduct a hazard analysis. Prepare a flow diagram of the steps in the process. Identify and list the hazards and specify the control measures.

Principle 2: Identify the CCPs in the process using a decision tree.

Principle 3: Establish target levels and tolerances which must be met to ensure each CCP is under control.

Principle 4: Establish a monitoring system to ensure control of the CCP by schedule testing or observations.

Principle 5: Establish the corrective action or preventive measures to be taken when monitoring indicates that a particular CCP is moving out of control.

Principle 6: Establish documentation concerning all procedures and records appropriate to these principles and their application.

Principle 7: Establish verification procedures which include appropriate supplementary tests, together with a review which confirms that HACCP is working effectively.

**Definition of terms used**

The definition of various terms employed in HACCP study is described by Codex (1991).

Preventive measures-those actions and/or activities that are required to eliminate hazards or reduce their occurrence to an acceptable level.

Corrective Action-the action to be taken when results of monitoring the CCPs indicate a trend towards loss of control.

Critical Control Point (CCP)-a step which, if controlled, will eliminate reduce a hazard to an acceptable level. A step is any stage in production and/or manufacture. This includes raw materials, transport to processing plants, processing and storage etc.

Hazard-this means the potential to cause harm. Hazards can be microbiological, chemical or physical. The National Marine Fisheries Services, also includes economic fraud as hazard, examples of which are species substitution, underweight, excess water in the glaze of frozen products etc.

Monitoring-checking that a processing or handling procedure at each critical control point meets the established criteria. Monitoring may be accomplished by:

(a) Observing handling practices and cleaning procedures;

(b) Measuring time/temperature, detergent/disinfection concentration, container/package condition, chlorine concentration in glaze water etc.

Verification-the use of supplemental tests and/or the review of monitoring records to determine whether the HACCP system is in place and is functioning as planned and to ensure that monitoring is carried out effectively and efficiently.

**HACCP analysis**

Before starting any study, senior management of the company must be committed to providing the necessary resources for the exercise to be completed and to implementing the findings of the exercise, including reviews and updates. Without such commitment there is little point in beginning the study. When conducting a HACCP study the seven principles are applied in the following stages (Anon, 1996):

(a) Define terms of references and set up the HACCP team;

(b) Describe the product-a full description of the product and the study, e.g. raw, frozen, peeled and de-veined shrimp together with a description of packaging methods, storage and distribution conditions, shelf-life and instructions for use;

(c) Identify intended use-this should be done in collaboration with the customer and the customer target groups should be defined;

(d) Construct a flow diagram-the format of the flow diagram is a matter of choice, but on-site verification of the flow diagram should be carried out;

(e) List all the hazards associated with each process step and list all measures which will control the hazards;

(f) Identify all the critical control points, which can be conveniently carried out using a CCP decision tree;

(g) Establish a monitoring system for each CCP; EG.RAW MATERIAL SHOULD BE STORED BELOW 5$^{o}$C;

(h) Establish a monitoring system for each CCP;

(i) Establish a corrective action plan;

(j) Establish a record keeping system and

(k) Establish verification procedures and review of HACCP plan.

**HACCP Team**

In order to fully understand the process and to be able to identify all likely hazards and CCPs, it is important that the HACCP team is made up of people from a wide range of disciplines. Dillon and Griffith (1996) described various functions that the team should cover.

There must be a chairman to convene the group and to direct the work of the team, ensuring that the concept is properly applied. It is, therefore, important that this person is familiar with the technique and is a good listener, allowing everyone to participate. Someone with a detailed knowledge of the production processes (a production specialist) is required to draw up the initial flow diagrams. Several specialists may be involved in the team, each with the understanding of particular hazards and associated risks, e.g. microbiologist, chemist, QC manager. A process engineer with detailed knowledge, and a good understanding of mechanical operations and performance of processing stages is required to be on the team. People, such as packaging specialists, raw material buyers or distribution staff, may be brought into the team temporarily in order to provide relevant expertise.

The team's progress and results of the analysis should be recorded, a technical secretary should ideally be used to allow all members of the team to play a full role in the discussions.

**Process flow diagram**

The first function of the team is to draw up a detailed flow diagram of the process. The expertise of the production specialist is important at this stage. Processes will differ in detail in different plants, and an accurate flow diagram depends on detailed knowledge of the process. Issues that may influence considerations of the process include:

(a) Management routine (e.g. shift patterns, skill levels)
(b) Process details (e.g. hygiene and design of equipment, plant layout)
(c) Other operations (e.g. design, storage areas, security)
An example of process flow diagram is given in Fig. 1.

**Defining product characteristics**

The team must next examine the product and identify its characteristics and way in which it will be used and handled. This analysis will help the team to determine the hazards that will threaten the product or consumer. The following headings can be used as a guideline to this process(Dillon and Griffith,1996)

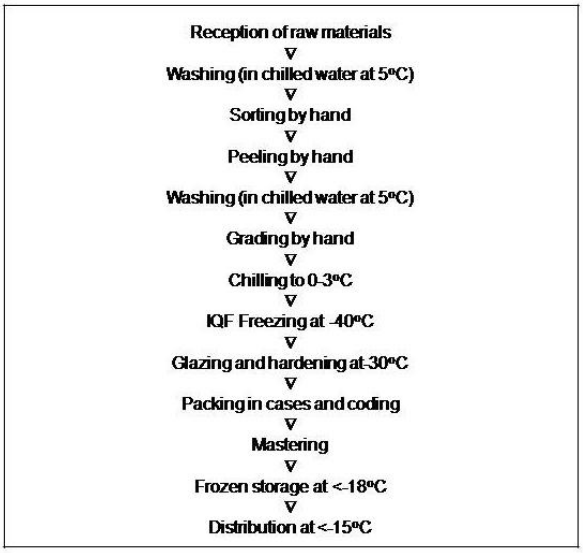
Storage: All products are handles and stored by the consumer. There is an opportunity for storage abuse that may lead to spoilage of

the product in the case of raw orcompromise the safety in the case of packaged products.

Preservation: Specific preservation systems may be used to extend the shelf life of foods and improve the safety. Traditional systems are being constantly modified to meet marketing demands and it is critical to understand the implications of these changes to the stablility of the product.

Packaging: Packaging will physically protect some products, and will also act as a barrier to microbial or chemical contamination.

Fig 1. Example of flow charting IQF raw shrimp processing




| Types of physical hazards | |
|---|---|
| **Hazard** | **Source or cause** |
| Glass | Bottles, jars, light fixtures, utensils, gauge covers, Thermometers |
| Metal | Nuts, bolts, screws, steel wool, wire, meat hooks |
| Stones | Raw materials |
| Plastics | Packaging materials, raw materials |
| Bone | Raw material, improper plant processing |
| Bullet/BB Shot/needles | Animals shot in field, hypodermic needles used for Infections |
| Jewellery | Pens/pencils, buttons, careless employee practices |

Agriculture chemicals: pesticides, herbicides, animal drugs, fertilizers, etc.

1. Plant chemicals: cleaners, sanitizers, oils, lubricants, paints, pesticides, etc.
2. Naturally-occurring toxicants: products of plant, animal or microbial metabolisms such as aflatoxins, etc.

3. Food chemicals: preservatives, acids, food additives, sulfating agents, processing aids, etc.

Environmental contaminants: lead, cadmium, mercury, arsenic, PCBs.

**BIOLOGICAL HAZARDS**

Biological hazards, which are mainly bacterial, can cause either food-borne infections or intoxications. A food- borne infection is caused by a person ingesting number of pathogenic micro-organisms sufficient to cause infection as a result of their multiplication, e.g. salmonellosis. A food- borne intoxication is caused by the ingestion of already formed toxins produced by some bacteria when they multiply in food, e.g. staphylococcal enterotoxin.

When assessing bacterial hazards to human health in meat and poultry products ,nine pathogenic bacteria must be considered. The following identifies and discusses the pathogenic micro organisms of concern.

Hazard Analysi scan also be performed by employing HACCP worksheet. Hazard analysis worksheet or HACCP work sheet is a tool used to evaluate all hazards in each processing step and to check whether that processing step is a Critical Control Point (CCP). Once CCP's are determined, HACCP planform is used for effectively manage and control all identified CCP's.

**Hazard-AnalysisWorksheet**

A hazard-analysis work sheet can be used to organize and document the considerations in identifying food-safety hazards. The worksheet addresses the first two principles of HACCP. Although there is no specific or required form, the worksheet should document specific information as required by FDA(Food and Drug Administration, USA). The first two principles of HACCP is being taken care by HACCP worksheet. A typical worksheet is depicted in Annex

1. Each work sheet should have the name and address of the production unit,name of the product, intended use of the product and target consumers and method of storage and distribution.Obviously separate worksheet is required for each class of products.

**DescriptionofFisheryProducts/IntendedUse**

The HACCP team look at all the fishery products produced in the facility and decide which products to be included in the HACCP Plan. Once the products are identified, the team has to prepare its

description, which include details such as composition,structure and physical characteristics, processing method, packaging, conditions for storage and distribution, shelf life, instructions for use and microbiological and/or chemical criteria (if any) of the product.

The HACCP team also has to state the intended use for the product which describes, target consumers, anticipated preparation and use of the product by consumers,special considerations if any (for example if the product is to be used in institutions or by traveler, etc. or are these dangers in use for any vulnerable groups in the population who might obtains the product) and specific requirements imposed by the importer or importing country. Examples of Product description and intended use of the product are given below.

**PRODUCTDESCRIPTIONOFFROZENRAWSHRIMP**

| | | |
|---|---|---|
| 1. | Species | 1. Penaeus indicus(white/NARAN)<br>2. Penaeus monodon(Tiger) |
| 2. | Type | 1.Headon(whole) 2.Headless(HL)3.Peeledand Deveined (PD) 4. PDTailon 5. Peeled and undeveined |
| 3. | Count | |
| 4. | FreezingMethod | IQF/BlockFrozen |
| 5. | Packaging | Packed in LDPE bags or laminated duplex cartons whicharepackedin5or7PLpaperboard |
| 6. | Storing | Stored at a temperature-18°C or below |
| 7. | Instructions for use | To be fully cooked before use or further processed in aproduct |
| 8. | Shipment/Transport | Refrigerated containers at a temperature-18°Cor below |

**INTENDED USE OF THE PRODUCT**

| | | |
|---|---|---|
| 1. | Name of the product | Frozen raw shrimp |
| 2. | Consumer | General public/and processing |
| 3. | Anticipated | Fully cooked before consumption |
| 4. | Special considerations | NIL |

Fig1 depicts a model of HACCP worksheet followed by Indian seafoodindustry. This model is adapted from USFDA. Each processing step should be listed serially in Column1 as given in the verified process flow diagram.

All the identified hazards biological, chemical and physical–for each processing step are listed in Column 2. Our assessment of each hazard, based on the evaluation of its significance and severity should be entered in Column 3. Your decision in column 3 should be logically and clearly justified in Column4. The possible preventive or control measures for each hazard are listed in column5.

Control or Preventive Measures

Control measures are actions and activities that can be used to prevent or eliminate a food-safety hazard or reduce it to an acceptable level. Control measures for various hazards can be obtained from stand ard literature, hazard guides, labelsetc. Examples of control measures are listed below:

**A.Control measures for biological hazards**

Bacteria and other pathogenic micro organisms Control of time and temperature ( Minimum storage time and adequate maintenance of temperature by icing, refrigeration etc will mimize the growth of harmful bacteria)

Retorting, Cooking, frying, drying ( high temperature exposure for the required time / removal of moisture to attain required water activity, will kill bacterial population) Quick Freezing, Chilling, Cooling ( will minimize / prevent the growth of bacteria) Fermentation, pickling or addition of preservatives etc (These will prevent the growth of some bacteria)

Source control (These controls assumes importance, when a particular hazard cannot be controlled by any processing activities. For example in the case of block frozen shrimps, salmonella can be controlled by developing suitable standard operating procedures to ensure that no contamination occur while harvesting and handling)

**HACCPWORKSHEET**

| | |
|---|---|
| **Name of the firm** | |
| **Address** | |

| | |
|---|---|
| **Product description** | |
| **Method of distribution and storage** | |
| **Intended use and Consumer** | |

| **HAZARD ANALYSIS WORKSHEET** | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| **Ingredient/ processing step** | **Identify potential hazards Introduced controlled or enhanced at this step** | **Are any potential Food safety Hazards significant** | **Justify your decision for column(3)** | **What control measure(s) can be applied to prevent the significant Hazards?** | **In this step A critical control point** |
| | **Biological** | | | | |
| | **Chemical** | | | | |
| | **Physical** | | | | |

B. Control measures for Chemical hazards

1. Source control (Antibiotics can be controlled by harvesting them from farms which practices approved standard operation procedures for application of antibiotics or by using only permitted antibiotics. These can be verified by auditing the farm facilities during the time of application of antibiotics. This is supplemented with supplier guarantee declaration and third party testing).
2. Production control (eg., Use and application of chemicals under expert guidance).
3. Labeling control (eg., finished product properly labeled with ingredients and known allergens).

C. Control measures for Physical Hazards

1. Source control (eg., vendor certification and raw-material testing).
2. Production control (eg., use of magnets, metal detectors, sifter screens, destoners, clarifiers, air tumblers, x-ray equipment, and visual inspection).

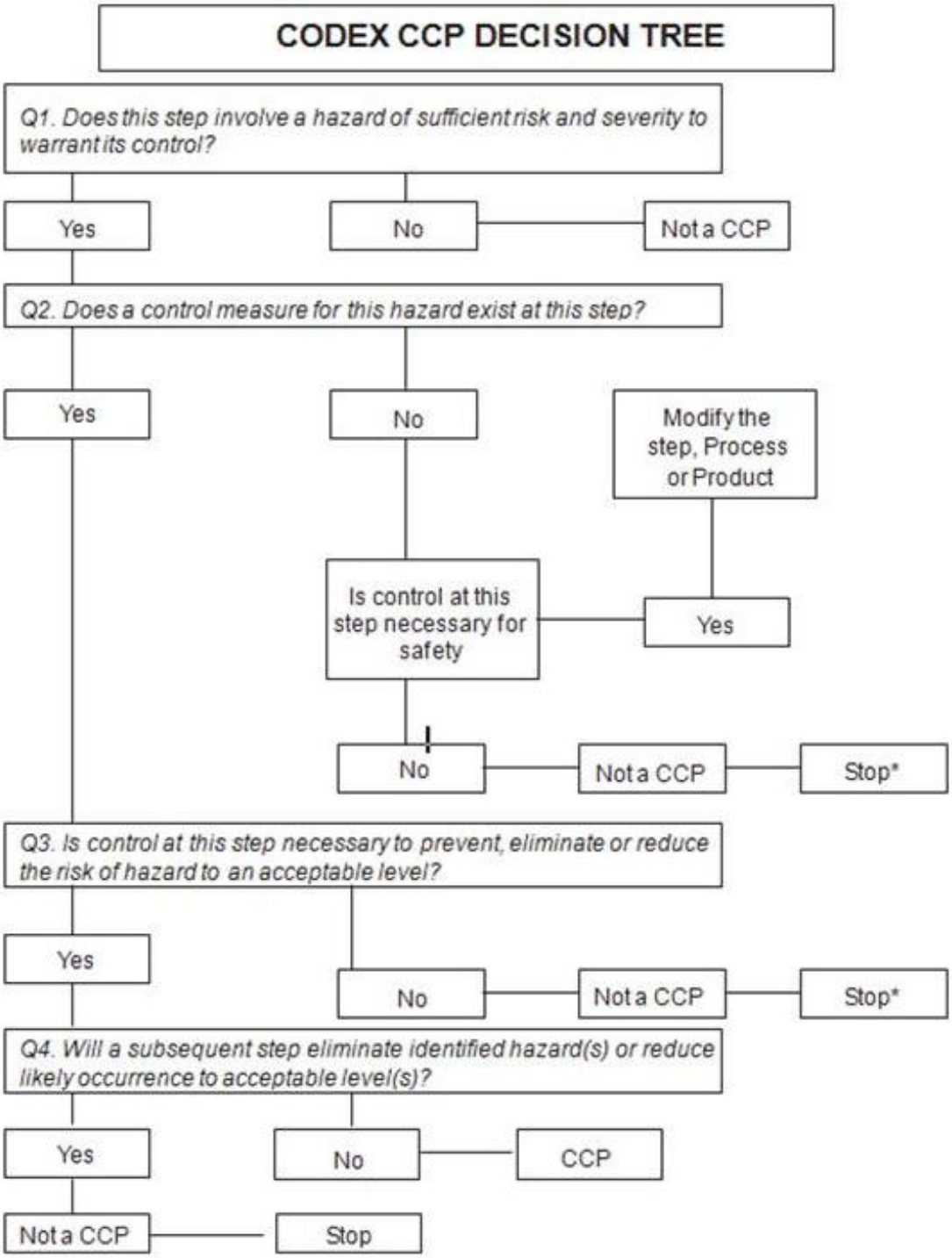
Determination the Critical Control Points

The next important step is to ascertain whether the processing step in question is a Critical Control Point ( CCP). This has to be entered in(Col no 6) of the worksheet. For each significant hazard, there should be a CCP in which the hazard in question is totally eliminated or brought

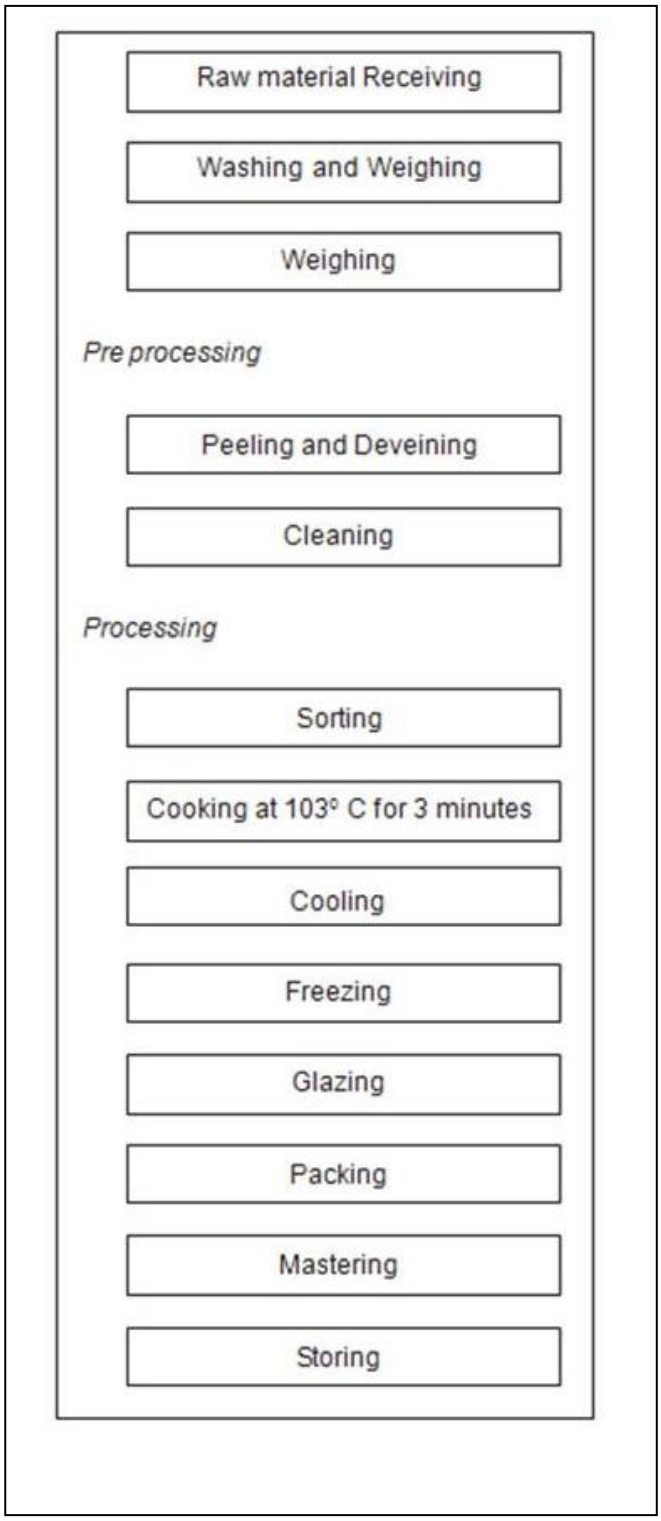
below the permitted limit. The determination of CCP is facilitated by the applying the decision tree developed by Codex Alimentarius Commission. (Fig 5.) A CCP is defined as that processing step, which effectively prevents and eliminates a food safety hazard or reduce it to an acceptable level. CCPs are product and process specific and CCP seen in one processing unit may not be applicable to another.

Description of CCP Decision Tree

CCP decision tree is a tool developed by Codex Alimentarius Commission, which can be employed to determine whether a particular processing step is a CCP. The decision tree consists of a series of questions the processor has to answer. Based on the answers, we will be guided to other related questions and determine whether the activity is a CCP. If properly used, the decision tree can be a useful tool for identifying CCP's. But as FDA says, the CCP decision tree is not a subsitute for the expert knowledge, since complete reliance on the decision tree might lead to false conclusions.


CODEX CCP DECISION TREE
Q1. Does this step involve a hazard of sufficient risk and severity to warrant its control?
Yes
No
Not a CCP
Q2. Does a control measure for this hazard exist at this step?
Yes
No
Modify the step, Process or Product
Is control at this step necessary for safety
Yes
No
Not a CCP
Stop*
Q3. Is control at this step necessary to prevent, eliminate or reduce the risk of hazard to an acceptable level?
Yes
No
Not a CCP
Stop*
Q4. Will a subsequent step eliminate identified hazard(s) or reduce likely occurrence to acceptable level(s)?
Yes
No
CCP
Not a CCP
Stop

Let us take an example of peeled and cooked prawn.The flowchart of the product is given in fig 6




**Question1.**Does a control measure(s)
exist at this step or subsequent steps in the process flow for the identified hazard?

If your answer is yes, proceed to Question 2. If you cannot identify a control measure in the process for the hazard, select No for the answer.

If No is selected,then ask:Is control at this step necessary forsafety?

If you have no as the answer here also, then this step is not a CCP for that hazard.Movetothenextprocessing step.

But If the answer is yes, then you have identified a significant hazard that is not being controlled. That means,your process or product must be redesigned to includea control measure.

**Question 2.** Does this step eliminate or reduce the likely occurrence of asignificant hazard to an acceptable level?

To answer this question, consider whether this is the **best** step control the hazard? If the answer is yes, then the step is a CCP. Move to the next food-safety hazard.

If the answer is no,Proceedto Question3.

**Question3.**Could contamination with an identified hazard or hazard so ccurin excess of acceptable levels,or could these increase to unacceptable levels?

The question refers whether contamination that already exists increases at this step. If the answer is no, then the step is not a CCP for that hazard. Move to the next hazard at that step or thenextstep with afood-safetyhazard.

If the answer is yes,then proceed to the fourth question.

**Question4.**Will a subsequent step eliminate the identified hazard or hazard or reduce the likely occurrence to an acceptable level?

If you answer no,then this step is a CCP.If you answer yes,then this step is not a CCP for this hazard.In this case,be sure the hazardi scontrolled by a subsequent processing step.

*HACCP Plan Form*

HACCP plan form is tool which helps to manage each CCPs.The plan form will address the last five principles of HACCP. A typical plan form is given in fig7.

Like in the worksheet, each plan form should bear the name and address of the production unit, name of the product, intended use of the product and target consumers and method of storage anddistribution.

The plan form will help you to1)set critical limits 2)establish monitoring procedures 3) determine corrective actions and4)design records (to positively document that the process is in control) for identified hazards in each CCP.

The plan form has ten columns. The Column1 in the HACCP Planform contains the CCP's,which are identified using HACCP worksheet.Column2 lists the hazards and critical limits are listed in column 3. Columns 4 to7 are meant for entering monitoring procedures, in which details of what to be monitored, how the monitoring is done, frequency of monitoring and the person sresponsible for monitoring are entered.Column8 details the corrective actions to be taken inc ase of any deviation.Column9 lists the various verification procedures required to validate our HACCP plan and column10 details the relevant records which are to b emaintained.

**CriticalLimit**

A maximum and/or minimum value to which a biological, chemical or physical parameter must be controlled at a CCP to prevent,eliminate or reduce to an acceptable level the occurrence of a food-safetyhazard.

A critical limit represents the boundaries that are used to ensure that an operation produces safe products. EachCCP must have oneormorecriticallimitsforeachfood-safety hazard. When the process deviates from the critical limit, a corrective action must be taken to ensurefoodsafety.

**HACCP PLAN FORM**

:

| | | |
|---|---|---|
| Name of the firm | : | |
| Address | : | |

| | | |
|---|---|---|
| Product Description | : | |
| Method of Distribution and storage | : | |
| Intended use and Consumer | : | |

| HAZARD PLAN FORM | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Critical Control Point (CCP) | Significant Hazard | Critical Limits | Monitoring | | | | Corrective Action (s) | Records | verification |
| | | | What | How | Frequency | Who | | | |
| | | | | | | | | | |

**HowtoestablishCriticalLimits:**

Critical limit for the operation may not be available ready made.They have to be fixed by conducting tests and validating them with competent laboratories.These tests may be designed and conducted in association with reputed laboratories or by consulting scientific publications, regulatory guidelines,in house experiments etc.

| Generalsource | Exampl |
|---|---|
| Scientific publications | Journal articles,foodsciencetexts, microbiology textsetc |

| | |
|---|---|
| Regulatory guidelines | National/International guidelines, BIS,EIA/MPEDA publications, tolerance and action levels, FDA or EU |
| Subject experts | CIFT,CIBA,CMFRI,thermal process authorities, |
| Experimental studies | Inhouse experiments, Accredited laboratories |

A few examples of critical limits are given below

| Hazard | CCP | Critical Limit |
|---|---|---|
| Microbial Pathogens | Cooking | $85^0$C for 3minutes for elimination of |
| Microbial Pathogens | Drying | $a_w$ <0.7 |
| Microbial Pathogens | Acidification | Batchschedule–pH<2,time28h |

We should understand that a variety of options are available for managing and controlling a hazard. Only experience and practicality will help you to select the best control measure that has to be adopted.

Monitoring :

Monitoring is the process by which hazard control is effected by ensuring the operations is well under critical limit. It is a planned sequence of observations or measurements to assess whether a CCP is under control. Monitoring also helps to produce an accurate record of operation,which will be useful verification.

Monitoring procedures can either be qualitative or quantitative.Sensory observation for decomposition is an example of a qualitative observation, whereas a temperature reading from a thermometeris aquantitative observation. Monitoring can be performed either in a continuous or in a periodic (non-continuous)basis. It is always desirable to have a continuous monitoring procedure, however, if it is non continuous, procedures should be reliably indicate that the hazard is under control.The means by which the observation is done should be given in the HACCP plan.Monitoring should be done on a

realtime basis, so that corrective actions can be taken in time,whenever deviations are observed.

Monitoring a CCP can be categorised into five viz.visual observation,sensory evaluation, physical measurement, chemical testing and microbiological examination. Visual monitoring needs no expensive equipment and may not even require highly specialized staff. Sensory evaluation can sometimes providea quick indication of loss of control. It can be used to check the quality of incoming raw materials.Bad odours can also provide a quick indication of loss of control. Physical measurements such a temperature, pH,water activity, humidity canbe made rapidly and are thus useful in monitoring processes where these factors are the means to control a particular CCP. Rapid chemical tests (eg. Chlorine level in water) are useful as means of monitoring CCPs. Microbiological testing and detailed chemical analysis areof limited use in monitoring CCPs. It can be employed for the testing of rawmaterials before starting processing, and fortesting critical finished products (eg.Ready to eat fish curry)before release. Monitoring also provide sarecord that products were produced incompliance with the HACCP plan.This information is useful inthe verification of the HACCPplan as discussed in Principle 7.

***Components of MonitoringSystem***

The monitoring procedure ensures that the required control measures are effective and hazards are kept below critical limits. This is done in the plan form by indentifying following parameters:

•What will be monitored(Direct/Indirect).(Column4)

•How the critical limits and control measures will be monitored.(Column5)

•How frequently monitoring will be performed.(Column6)

•Who will perform the monitoring.(Column7)

***Whatwillbemonitored***

It can be a measurement of a product characterestcora processing

*Examples*

•Measurement of boiler compartment temperature

•Measurement of the pH of pickle.

•Measurement of convey or belt speed

It can also a subjective measurement which involves observation of a control measure to manage a hazard..

*Examples*

•Checking that a supplier's certificate accompanies a lot of raw material.

• Auditing the farm premises to check whether the fish farmer is using the permitted antibiotic and whether he applies it as per guidelines.

***How Critical Limits and Control Measures will be monitored?***

Monitoring must be designed to provide rapid (real-time) results. There is no time for lengthy analytical testing because critical limit failures must be detected quickly and an appropriate correctiv eaction instituted before distribution.

*Examples*

- Time and temperature using a calibrated thermometer and to watch.
- Water Activity ($a_w$) using a calibrated RH meter.
- Acidity (pH) using a calibrated pHmeter.
- •Visual observation for subjective evidences like supplier's guarentee, freshness using sensory evaluation etc.

***Frequency of monitoring***

As mentioned above, monitoring can be continuous or non-continuous.Where possible, continuous monitoring should be used. Continuous monitoring is possible for many types of physical and chemical parameters.

Examples of continuous monitoring include:

The time and temperature of a batch cooker process for IQF shrimps may be continuously monitored and recorded on a temperature-recording chart.

Checking for presence of metals in frozen shrimp blocks using a metal detector.

Examples of non-continuous monitoring include:

- Routine,dailychecksfortemperatureofstoredfishwaitingforprocessing.

Periodic sensory examination for decomposition in histamine forming seafood.

***Who will do the Monitoring?***

Assignment of there sponsibility for monitoring is an important consideration when developing a HACCP plan.

Individual sassigned to CCP monitoring can be:

•Line personnel,

•Equipment operators,

•Supervisors,

•Technologist

**CorrectiveActions**

Corrective actions are predetermined procedures to be adopted when criticallimits at a CCP is compromised. These procedures should restore process control and state clearly the method of disposing the product produced during the deviation.

An effective corrective action plans must:

Correct and eliminate the cause of the non compliance to assure that the CCP is brought back under control.

Segregate, assess and determine the disposition of the non compliant product.

All corrective actions taken must be documented. Documentation will assist the firm in identifying recurring problemss othat the HACCP plan can be modified. Additionally,corrective action records provide proof of product disposition.

An example of disposition procedure for an affected product is given below:

Isolating and holding product for safety evaluation. If the product was found to be safe, release the product

Diverting the affected product or ingredients to another line where deviation woul dnot be considered critical.

- Reprocessing.
- Destroying product.

It may be necessary to determine the cause of the deviation to prevent future recurrence. A critical limit failure that was not anticipated or reoccur sshould result in an adjustment to the product or processor are-evaluation of the HACCPplan.

Verification procedures

Verification are those activities, other than monitoring, that determine the validity of the HACCP plan and that verify the system is operating according to the plan. The purpose of the HACCP plan is to prevent food-safety hazards, and the purpose of verification is to provide a level of confidence that the plan is based on solid scientific principles, is adequate to control the hazards associated with the product and process,and is being followed.

**Parts of Verification:**

•Validation

•CCP verification activities

–Calibration of monitoring devices

– Calibration record review

– Targeted sampling and testing

– CCP record review

•HACCP system verification

–Observations and reviews

–Microbiological end-product testing

• Regulatory agencies

Validation: Th eelement of verification focused on collecting and evaluating scientific and technical information to determine if the HACCP plan, when properly implemented, will effectivelycontrol the hazards.Validation can be performed bytheHACCP team or byan individual qualified by training or experience.. Validation involves a

scientific and technical review of the rationale behind eachpart oftheHACCP plan from hazard analysis through each CCP verification strategy.

***Verificationof CCPs*** Verification activities developed for CCP sare essential to ensure that the control procedures used are properly functioning and that they are operating and calibrated within appropriate ranges for food-safety control. CCP verification may also include targeted sampling and testing.

- ***Calibration***

Verification activities at CCPs include calibration of monitoring devices to ensure the accuracy of the measurements taken with traceability. Calibration is conducted to verify that monitoring results are accurate.

Calibration of CCP monitoring equipment is fundamenta lto the successful implementation and operation of theHACCP plan. If the equipment isout of calibration,then monitoring results will be unreliable.Frequencyof calibration should also be influenced by equipment sensitivity.

- ***Calibration Record Review***

Reviewing the equipment calibration records involves checking the dates andmethods of calibration and the test results

- ***Targeted Sampling and Testing***

Verification may also include targeted sampling,testing and other periodic activities. Vendor compliance may be checked by targeted sampling when receipt of materialisa CCP and purchase specification are relied on critical limits.Typically,when a monitoring procedure is not as stringent as desired,it shouldbe coupledwith a strong verification strategy.

- ***CCP Record Review***

Atleast two types of record sare generated at each CCP:monitoring and corrective action. These records are valuable management tools,providing documentation that CCP sare operating within established safety parameters and that deviations are handled in a safe and appropriate manner. However, records alone are meaningless unless someone in a supervisory capacity reviews them on a periodic basis to “verify” that the HACCP plan is being followed.

**HACCP System verification**

In addition to the verification activities for CCPs, strategies should be developed for scheduled verification of the complete HACCP system. The frequency of the system-wide verification should be yearly (at a minimum) or whenever there is a system failure or a significant change in the product or process. The HACCP team is responsible for ensuring that this verification function is performed.Often, the HACCP team will contract an independent third party to conduct the system-wide verification

**Activities**

***•System Verification Activities***

Systematic verification activities include on-site observations and record reviews.Reviews are usually performed by an unbiased person who is not responsible for performing the monitoring activities.System verification should occur at a frequency that ensures the HACCP plan is being followed continuously. This frequency depend son a number of conditions,such as the variability of the process and product.

***•End-Product Microbiological Testing in HACCP Verification***

As explained in Chapter 2, microbiological testing is ineffective for routine monitoring but can be used as a verification tool. Microbiological testing can be used to determine (e.g., during verification audits or on periodic basis that the overall operation is under control.)

**Record-Keeping Procedures**

Accurate record keeping is an essential part of a successful HACCP program.Records provide documentation that the critical limits have been metor that appropriate corrective actions were taken when the limits were exceeded.Likewise,they provide a means ofmonitoring so that process adjustments can be made to prevent a loss of control.

**Four kinds of categories are kept as part of the HACCP system.**

1.HACCP plan and support documentation used in developing the plan
2.Records of CCP monitoring
3.Records of corrective action
4.Records of verification activities

**Conclusion**

HACCP was designed to prevent hazardous products from leaving the manufacturing or processing facility. The key tothe success of HACCP is employee training, behavior and attitude. Some companies are under them is conception that theyalready havea HACCP plan because they are adequately controlling all area where safety could be compromised.The difference is that, rather than monitoring isolated processing steps, an HACCP approach controls the entire production process as an integrated system.

Although HACCP provides insurance that poultry is safe, there is no way to completely eliminate all hazards.HACCP is most effective when usedwith other control systems. Total Quality Management programs and Standard Operating Procedures should be used along with HACCP to improveproduct safety,product quality, and plant productivity by providing intimate knowledge of the production process, production environment and processing equipment.