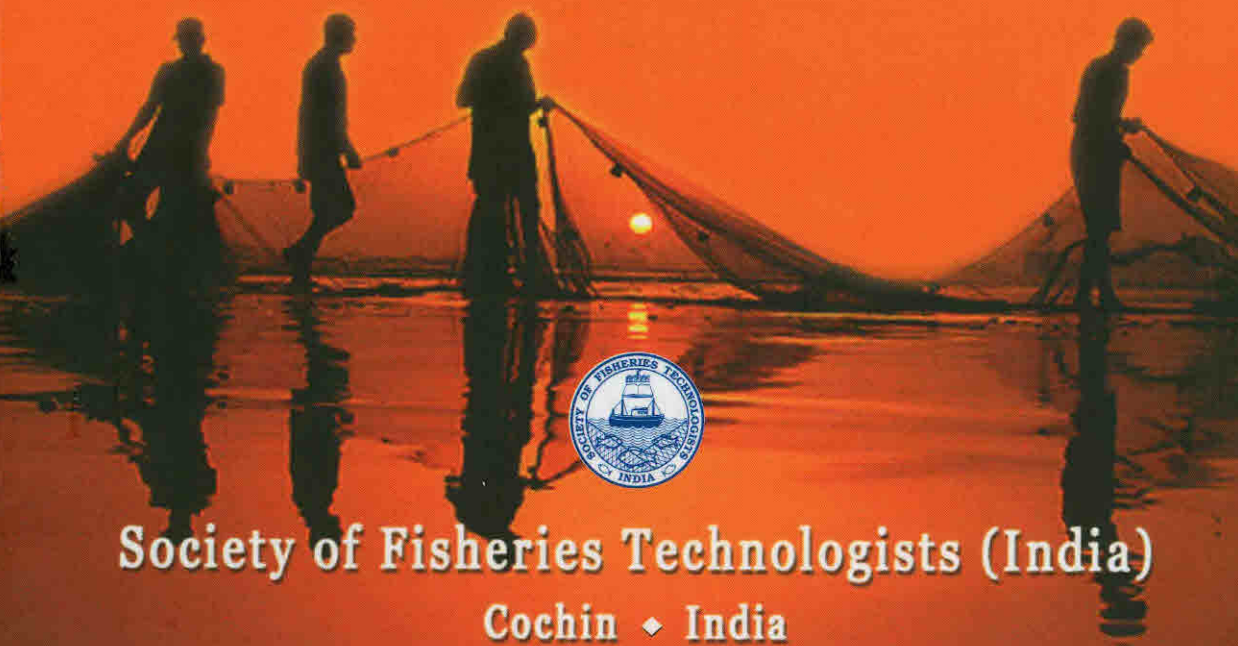
Coastal Fishery Resources of India

Conservation and Sustainable Utilisation



Society of Fisheries Technologists (India)

Cochin ◆ India

Coastal Fishery Resources of India: Conservation and Sustainable Utilisation

Proceedings of the National Seminar on Conservation and Sustainability of Coastal Living Resources of India, 1-3 December 2009, Cochin

Organised by

Society of Fisheries Technologists (India), Cochin
and
Centre for Ocean and Environmental Studies, New Delhi

In association with

Ministry of Earth Sciences (New Delhi)
Central Marine Fisheries Research Institute (Cochin)
National Institute of Oceanography (Goa) and
Central Institute of Fisheries Technology (Cochin)





ISBN: 978-81-901038-7-9

Published by

Society of Fisheries Technologists (India)
P.O. Matsyapuri, CIFT Junction, Cochin - 682 029, India

URL : www.fishtech.org
Phone : 91 (0)484-2666845
Fax : 91 (0)484-2668212
Telegram : FISHTECH / MATSYAOUDYOGIKI
E-mail : cift@ciftmail.org
enk_ciftaris@sancharnet.in

Citation:

Rao, G.S. (2010) Current status and prospects of fishery resources of the Indian continental shelf, In: Coastal Fishery Resources of India: Conservation and Sustainable Utilisation (Meenakumari, B., Boopendranath, M.R., Edwin, L., Sankar, T.V., Gopal, N. and Ninan, G., Eds.), p. 1-13, Society of Fisheries Technologists (India), Cochin

Cover design: Vineethkumar, P., CIFT, Cochin

Printed at PAICO, Cochin - 682 035, India

Coastal Fishery Resources of India

Conservation and Sustainable Utilisation

Editors

B. Meenakumari
M.R. Boopendranath
Leela Edwin
T.V. Sankar
Nikita Gopal
George Ninan

Society of Fisheries Technologists (India)
P.O. Matsyapuri, CIFT Junction, Cochin - 682 029, India

2010

Seafood Safety and Quality

M.K. Mukundan
Council for Food Research and Development Kerala
P.O. Perinjottackal, Konni, Pathanamthitta, Kerala, India
E-mail: mkmukundan@gmail.com

Introduction

Seafood occupies a unique position as food material for man. several nutrients both major and minor are available in almost all fish and fishery products from marine and freshwater bodies. They also contain various types of bioactive compounds useful to control various ailments posing threat to human health. The good taste, high nutritional quality and easy digestibility of fish make it a favorable food of almost all living organisms including bacteria and animals. As a result all organisms compete to consume fish and fishery products and, if handled carelessly, fish and fishery products can become a source of different kinds of public health organisms such as *Vibrio cholera, Salmonella typhi, Listeria monocytogenes, Vibrio parahaemolyticus* and *Salmonella aureus* (Nambiar and Surendran, 2003) as well as toxic compounds like histamine, microbial toxins, toxic pesticides and heavy metals causing various kinds of infectious diseases and food poisoning in man.

The species of aquatic organisms used as food are too many. Some of these organisms by virtue of their genetic make up or food habits are found to contain some toxic substances. Thus ciguatoxin, paralytic shellfish poison (saxitoxin), diarrhetic shellfish poison (okadaic acid), amnesic shellfish poison etc are species related toxins, which are health hazards encountered in sea food (Huss, 1994; Schantz, 1984) Similarly scombroids or more generally fishes with red meat on temperature abuse produce histamine and cause the commonly reported scombrotoxin poisoning (Taylor, 1986). Some species, particularly bivalves are known to accumulate certain heavy metal residues from the eco system to toxic levels. The cephalopods, squids and cuttlefish are found to accumulate lead and cadmium depending on pollution of the environment as well as age of the organism. On a similar fashion, large fishes like tuna and marlin are known to accumulate mercury to toxic levels with increase in age and size. Fish and shellfish raised by farming are reported to concentrate environmental contaminants and aquaculture drugs like pesticide residues,

hormone residues and antibiotic residues (Surendran, 2003). All these residues pose various kinds of health risks to consumers. Thus, the occurrence of pathogens, pollutants, toxicants and other undesirable compounds in fishery products and food items in general is fast becoming a common phenomenon in developed and developing countries. A list of such health hazards encountered in fish and fishery products along with their tolerance limits are shown in Table 1.

Table 1: Typical seafood borne hazards and their critical limits*

Significant hazards	Critical limits
PSP	$80mg.100g^{-1}$
DSP	$20mg.100g^{-1}$
Histamine.	$25\text{-}50mg.100g^{-1}$
Staphylococcus toxin	Absent
Botulinum toxin	Absent
Hormone residues.	Absent
Sanitizers & lubricants	Absent
Pathogens (in 25 g)	Absent
Parasites	Absent
Foreign matter (fish hook, metal fragments, etc.)	Absent

* Source: WHO, 1989.

In spite of all these health hazards, fish and shellfish continue to be in great demand as a food material in the developed world on account of the better taste, nutritional quality and medicinal properties. To avoid public health problems while using fish and shellfish as food for mass consumption, several quality assurance programmes were evolved and enforced from time to time. Today, various kinds of quality standards like Codex standards, US FDA standards, EU Norms and BIS standards are in operation at international and national levels. To achieve these standards several quality assurance programmes were also developed and practiced in different parts of the world. The Hazard Analysis Critical Control Points (HACCP) system of USA, the European Council Directives, the Quality Management Program (QMP) of Canada and Total Quality Management (TQM) of Japan are such quality assurance programmes aimed to ensure food safety and quality for fish and fishery products consumed in these countries (Mukundan, 2003; Iyer, 2003; Barker and McKenzie, 1997). With change of time all these quality standards and quality assurance

programmes became more and more stringent and mandatory and posed severe challenges to the developing countries, which used to export a major share of their fish and fishery products to these developed countries. As a result, many developing countries including India had to face trade ban on seafood exports. The imposition of HACCP in the early nineties by US FDA, the EU ban of fishery products from India in 1997 on account of lack of sanitation and hygiene and recent rejection of several consignments on account of antibacterial substances, antibiotic residues, heavy metal residues and muddy moldy flavour by USA, EU and Japan played havoc in Indian seafood industry. Even though TQM of Japan aimed total quality management, it failed to ensure both safety and quality, probably due to certain lacuna like calibration, good laboratory practice and good personnel policy. There were several attempts to improve the TQM concept of Japan to make it suitable to tackle all problems of safety and quality of a given food. A judicious combination of HACCP, Good Manufacturing Practices (GMP), Standard Sanitation Operation Procedure (SSOP) and Good Laboratory Practices (GLP) to eliminate food safety hazards and quality defects was attempted in food production lines and was successful in giving safe food products (Lupin *et al.,* 1997). This combination popularly called HACCP and Pre-requisite Programmes was made mandatory in several developed countries like EU and USA as well as for those food processing and exporting units exporting to these counties. In 2005, the ISO came up with a unified standard, *viz.,* ISO 22000 Food Safety Management Systems (FSMS) to implement HACCP and PRPs in food production and processing units (FDA, 1980; ISO, 2007).

Today, ISO 22000 harmonized and adopted in India as IS/ISO22000, 2006 is a widely used technique for quality assurance in a wide range of food processing industries. The use of IS/ISO 22000 is gaining more and more importance in Indian seafood industry perhaps due to the higher incidence of health risks and hazards in fish and fishery products as well as to tackle the challenges in the name of quality and safety posed by major importing countries like the European Union, USA and Japan. In India, the Central Institute of Fisheries Technology (CIFT), Cochin played the key role to equip the Indian seafood industry to face these formidable challenges by introducing a total quality management concept. The action plan popularized by CIFT consisted of preparation of HACCP manual, validation, installation of HACCP based processing and implementation of GMP, SSOP, GLP and good personnel policy, auditing to identify deficiencies, rectification of deficiencies.

Apart from various hazards, different types of defects are also encountered in fish and fishery products. Unlike hazards, defects are non-infective and non-injurious to consumers, while they reduce the consumer acceptance. Conventional defects are high TPC, hygiene and sanitation indicators, chemical components like TMA, indole, hypoxanthine and certain organoleptic criteria like mal odours, unnatural colours, texture and flavour. Defects often arise as a result of faulty handling and preservation under poor sanitation and hygiene. Poor GMP like non-standard methods, un-validated processing techniques also can contribute to quality defects (Wessells and Anderson, 1992;1993; Wessells et al., 1996). The quality standards for fish and fishery products and tolerance limits are indicated in Table 2.

Table 2: Quality standards for fish and fishery products and tolerance limits*

Parameters	Tolerance limit.
TPC	$<5\times10^5$
Escherichia coli	<20
Staphylococcus aureus	<100
TMA/TVBN	<35 mg.100g^{-1}
Indole	<25 mg.100g^{-1}
Peroxide value (for dried fishery products).	<10 m eq.100g^{-1}

*Huss, 1994

Sources of hazards in seafood production and control measures

Even though IS/ISO 22000 is widely used, depending on various factors, the approach and concepts for its implementation vary from industry to industry and from person to person. Obviously there is a need for consolidation of all relevant aspects to attain uniformly assured quality for products of mass consumption. The following logical steps introduced by CIFT in tune with IS/ISO 22000 to prevent health hazards and quality defects from all possible sources in the processing activity in Indian seafood industry was effective in achieving food safety. The logic adopted is to list out all possible sources of health risks and hazards in the processing procedure. In any system of food production, the risks and hazards arise from one or a combination of following sources or processing steps such as (i) seed production, (ii) farming and harvesting, (iii) raw material, (iv) production process, (v) production facility (plant and

machinery), (vi) personnel involved in production, (vii) cleanliness of food contact surfaces, (viii) pests, (ix) risk and hazard monitoring facilities and (x) availability of qualified and trained personnel. Therefore, the best method to achieve food safety shall be to critically evaluate each one of the above sources and to streamline the process to ensure that health hazards are reduced below tolerance level. This exercise needs the support and skill of a team of experts with a thorough knowledge of the raw materials, production processes, hygiene, and sanitation. A judicious selection of personnel responsible for purchase, production and quality control can address these issues. The team shall have the skill and expertise to identify possible significant physical, chemical and biological hazards that can be associated with the raw materials, processing steps, plant and workers. The team shall also be in a position to provide suitable remedial measures to exclude possible hazards from each and every source. A brief description of possible hazards at the above sources and control measures recommended are discussed in the following sections.

Seed production

During seed production several inputs and operations are used. Most of the inputs and operations may have only a short life and they will disappear during maturation of the seed without even any impact on the environment. Such inputs and operations will not carry any threats for food production. On the other hand, there are certain inputs and operations, which will leave a lasting toxic residue in the seed or release toxic residues to the environment, which will remain stable and is transmitted to the next generation food crops and food products origninating from it.

Raw materials

In a food processing plant, raw materials can be the raw food material as well as materials like food additives, food preservatives and packaging materials. Each one of these can contain hazards arising out of contamination, genetic origin and stage of harvest. Sea caught fish and shellfish are generally free from indicator organisms and other pathogens. But if the fish is landed on unclean surfaces and handled by personnel with poor hygiene, these organisms will find their way into the fish and pose health risk. Similarly, PSP (paralytic shellfish poisoning) and DSP (diarrhetic shellfish poisoning) in bivalves (WHO, 1984), lead and cadmium in cephalopods and histamine in scombroid fishes are commonly encountered health hazards in raw, fish and shellfish. In case of fish from inland water bodies and culture systems, there is not only the possibility occurrence of pathogens but also pollutants and drug residues like

pesticide residue, and antibiotic residue. By judicious selection of raw materials and appropriate control measures like harvest area certificate, supplier guarantee and random analysis, hazards arising from contamination, location & stage of harvest, species etc. can be excluded. During harvesting, control measures like landing and sorting the catch on clean raised platform, quick chilling of the catch followed by chilled/ iced storage till it is delivered to the land based factories, following good manufacturing practice (GMP) and standard sanitation operation procedure (SSOP) can minimize many of the biological hazards. A model SSOP has been prescribed by MPEDA (1977). Certain problems of genetic origin can be excluded by appropriate preparation and pre-processing methods such as removal of specific organs responsible for accumulation of toxic residues such as gutting of cephalopods to overcome heavy metal contamination. Further to avoid temperature abuse and handling problems, a code of practice for icing and fish handling on board, on landing and during transportation could be drawn up and popularized among fishermen, landing center workers and transport operators.

Production process

All seafood production processes will have a combination of different processing steps like washing, dressing, treatment with chemicals, cooking and freezing of the raw materials to give finished products. At all these steps the food material will come into contact with different contact surfaces like tables, utensils, processing equipments and workers' hands and, in the absence of sanitation and hygiene, all type of hazards can enter the food being processed. Certain processing steps are also known to reduce or eliminate certain hazards. Thus chilling or freezing is effective in preventing bacterial multiplication as well as histamine formation. Evisceration of cephalopods will reduce lead and cadmium toxicity. Cooking and pasteurization result in the elimination of pathogens. In order to ensure safety and quality, all these steps shall be evaluated properly to identify significant hazards introduced in each step and devise procedures for their control and monitoring. The thermal process validation for cooking and thermal processing, properly designed GMP and SSOP formulated by CIFT for all other processing steps tightened the entire processing operation and helped the Indian seafood industry to ensure safety and quality assurance in the production process.

The Seven Principles of HACCP

The HACCP is implemented, based on the following principles (Codex, 1995; Iyer, 1998):

Conduct a hazard analysis

Prepare a flow diagram of the steps involved in the processing of the raw material to the product. Identify and list the significant hazards if any for each processing step and specify control measures which will minimize or eliminate the identified hazard. Ultimately this will give us all the significant hazards and then location in a process. CIFT has developed suitable HACCP work sheet for all the products both for raw and cooked products and passed on the same for the benefit of the industry.

Identify critical control points (CCP) in the process

This is best done by following the CCP decision tree or based on the definition that CCP is that processing step which provides maximum control of an identified hazard. For each significant hazard there will be a CCP at some appropriate processing step arrived at as above. In case of aquatic food from India, the most common hazards are PSP and DSP, in the case of bivalves and bivalve eating organisms like crab, octopus and rays; lead and cadmium in the case of cephalopods; histamine in the case of scombroid fishes; antibiotic and pesticide residues in the case of farmed organisms; and biological pathogens, in the case cooked products. The CCP for all these hazards, except biological pathogens, is at the raw material receiving point and for biological pathogen it is at the cooking point.

Establish critical limits

In case of biological pathogens and physical hazards the critical limit is absence and incase of chemical hazards appropriate tolerance levels are prescribed based on Codex, US FDA, and EU Norms. Critical limits for certain seafood borne hazards arrived at in this style are listed in Table 1. In a production process all the significant hazards identified shall have a critical limit and the products shall achieve these critical limits by effective monitoring at appropriate control points.

Establish monitoring procedure

These are procedures to ensure that the significant hazards at appropriate CCPs are always maintained with in the tolerance limit established, by directly or indirectly testing or observing the significant hazards. In short for all significant hazards, there will be one or more monitoring procedures.

Establish corrective actions

These are control measures taken when monitoring indicates that a particular CCP is moving out of control, so that the significant hazard does not exceed the critical limit. Corrective actions are often remedial measures like adjusting cooking time and cooking temperature as per validated processing procedures to ensure proper cooking in case of under-cooking or presence of biological hazard, gutting of cephalopods in the case of lead and cadmium contamination or avoiding the particular source of supply in case of other kinds of chemical hazards.

Establish verification procedure

Verification involve checking of calibration tests, together with a review of actual analytical data (in case of indirect monitoring), which confirms that HACCP is working effectively and the products are safe for human consumption. In other words verification procedures are methods for effective cross checking of all control measures such as CCP monitoring, SSOP and GMP monitoring including relevant records by which the verification and audit team or any other interested party can conclude that HACCP procedures are working effectively and that the products are safe.

Establish a documentation system

All data on CCP monitoring, verification procedures, deviations and corrective actions if any as well as details of GMP and SSOP shall be recorded for inspection and audit. These records shall be preserved for a minimum of three years for review and audit in case of any complaints.

Operation as per seven principles of HACCP will ensure safety of the finished product from processing operations. As these operations are happening inside a building with a set of facilities like machinery and personnel. The building and facilities shall also be properly selected, laid out and operated to ensure food safety and quality. The procedure for setting up building, machineries and personnel as per food safety norms is termed Good Manufacturing Practice (GMP) and maintaining them on a daily basis in neat and clean condition is called Standard Sanitation Operation Procedure (SSOP) (Anon, 1996). Therefore, to achieve total food safety along with HACCP, there is need for operation of GMP and SSOP, collectively known as Pre-requisite Programmes (PRPs). Operation of HACCP and PRPs together in a food production line is bound to give safe and quality food products (Lupin *et al.*, 1997; Santos *et al., 1997*; 1998).

The production facilities

Plant, machinery and other facilities are an important factor which, if not properly selected and laid out, can lead to safety risks. GMP are largely the procedures laid down for achieving safety from plant, machinery and other infrastructure used in the production. The technical requirements, choice of materials and cost may be found in a number of publications such as Shapton and Shapton (1991), Imholte (1984), Troller (1983) and Hayes (1985). The important elements of GMP are listed below:

Plant design, construction and layout

In any production plant, there will be raw materials and finished products as well as one or more intermediate products. The plant design shall be such that the movement of edible materials from raw materials stage to the finished products stage is unidirectional and opposite to the movement of waste materials like solid wastes and liquid effluents. Another aspect of the plant design and construction is the nature of the materials used for the construction and the type of construction. All materials used shall be water resistant, washable and with a smooth surface. Further the construction shall be such that there is no sharp corners and that all wall to wall, wall to floor and wall to roof joints are round and smoothened. The design shall take care to provide fly proofing of all external openings like doors, windows, ventilators, chute doors and drain outlets. In fact the safety at drain outlets shall be such that there is no chance for any solid particles to go out as well as no fly can enter into the food handling areas. The plant will also need several electrical and mechanical fittings. All such items shall be washable and laid out in such a way that there is no scope for pest or microbial contamination. Information on hygienic design are found in Anon (1982; 1983), Milledge (1981) and Katsuyama and Strachan (1980). To achieve these objectives the CIFT has come up with seafood processing plant layout for pre-processing and processing of raw and cooked products. Plans for water purification for process water, effluent treatment system, common cold storages were also prepared and popularized in the industry.

Machinery design, construction and layout

Like plants, machinery too shall be designed, constructed and installed to facilitate unidirectional movement of food materials and that the machinery is water resistant, washable and sanitisable. All the machinery shall also be in a position to achieve criteria for good

manufacturing practice. To cite an example, the machinery for quick freezing shall be in a position to freeze the food in such a way that the core of the food attains -18 to +2°C, in 90 minutes. Similarly equipments for cooking shall be able to attain the validated cooking temperature and time without causing under-cooking or over-cooking. Selection and installation of processing machinery in this way will exclude all possible health risks from machinery.

Provision for pest control

The provision for pest control is often a neglected item. Pest can be the cause for both filth and contamination with microbes of public health significance. Exclusion of pests is best done by providing fly proof netting for all windows and ventilators as well as providing automatic air curtain and self closing shutters for all doors and chutes, directly opening to outside. There shall also be fly proof netting for drain outlets. Further to take care of any pest by passing these facilities there can be electrical fly catchers and rodent traps at strategic locations. Effective operation of these facilities will make food handling areas free from pests. For pest control there shall not be any chemical based pest control procedures. In rodent traps, the baits shall be only food items like dried and baked coconut or fish. Poison baits shall never be used for rodent control in food processing plants. In case there is any unusual fly population fumigation with formaldehyde followed by de-fumigation with ammonia can be followed. However there shall not be a regular schedule for fumigation as it may introduce unwanted chemical residues into the food material handled in the plant. Typical layouts for pre-processing centers, processing centers, common cold storage and pest control measures provided to the industry by CIFT are available for adoption by interested parties.

Personnel involved in production

Workers or plant personnel are the most dynamic source of various type of microbial contamination in any food processing establishment. In case of food materials from land and inland water bodies there is every chance of occurrence of organisms of public health significance. But in case of seafood the occurrence of Public Health Indicator organisms is a sure indication of poor hygiene and sanitation. To exclude such contamination from workers, all personnel in the production unit shall follow good hygiene practice. Important elements of good hygiene practices recommended by CIFT are discussed in the following sections.

Medical fitness of workers

Medical examination to certify the workers is an exercise to be done with out failure once in a year. To certify a worker to be fit to handle food actually involve three important steps. The first step involves examination of the worker by a qualified medical practitioner to rule out that the worker is not suffering from any disease. This the Doctor can do by physical examination and certain investigations on blood urine and stool. The second step is to exclude the possibility of the worker as a carrier of certain pathogens especially salmonella. This can be ensured only by conducting a stool culture test for salmonella. These two tests will ensure that the worker is fit to handle food materials. These tests are normally done once in a year. During this period there is no guarantee that the worker will not contract any disease or become a carrier. The third step is to guarantee that the worker will remain fit until next examination. This is ensured by immunization of workers against typhoid and other target diseases. Medical fitness of workers following the above steps will ensure exclusion of pathogens from workers.

Use of clean uniform including gumboots, head cover, face mask and gloves

Medical fitness is only a guarantee against contamination with pathogens. The body of the workers is still prone to various types of contamination and a sure source of different kinds of bacteria of public health significance. To avoid such contamination from workers there shall be proper isolation of workers body in such a way that directly or indirectly body of workers does not come into contact with the food or food contact surfaces. This is effectively done by providing clean uniforms including gumboots, head cover and face masks. While head cover prevent falling hair and subsequent contamination face mask will prevent spillage of saliva and nasal secretion and introduction of *Staphylococcus aureus*, which is a hygiene indicator as well as a food poisoning organism. Wherever high risk products are handled use of sterile disposable gloves is compulsory for all personnel entering high risk areas.

Removal of ornaments and other beauty aids

Ornaments and certain beauty aids offer lot of gaps and crevices which are very difficult to clean and so form easy home for various kinds of bacteria, which will be extremely difficult to eradicate. Hence, removal of all type of ornaments by all employees is essential before they enter the food handling areas for achieving safety of the food processed.

Scrubbing of hands

Use of single use sterile gloves by all fish handling personnel is ideal to prevent contamination from workers. Whether the workers use gloves or not it is very essential that they scrub their hands with soap and clean water. The hands shall then be dried with a clean towel before the workers enter the food handling area with or with out gloves. This practice will make the hands of the workers safe.

Sanitizing footwear

The bottom of the gumboots the workers wear in change room may cause some contamination. This is prevented by allowing the workers with gumboots or other factory provided footwear to pass through a foot dip containing 100 ppm available chlorine, which will sanitize the bottom portion of the footwear and prevent contamination of floor of the food handling area.

Hand sanitizing

Once the workers enter the food handling area, they shall sanitize the hands before starting the work by dipping the full palm preferably from elbow down of both hands in 20 ppm chlorine water. This procedure will enable the removal of significant bacterial load from the palms of workers and they will be safe for food handling. The above steps will take care to prevent of all sorts of contamination from workers.

Cleanliness of direct and indirect food contact surfaces

Another factor responsible for contamination is the cleanliness of direct and indirect food contact surfaces. There shall be identification and listing of all food contact and non contact surfaces followed by a cleaning procedure and cleaning schedule. All these operations are popularly known as Standard Sanitation Operation Procedure (SSOP). The following are the main elements of SSOP. The available chlorine content recommended by CIFT for different types of sanitizing operations is detailed in Table 3.

Cleaning and maintenance of water source, storage and supply lines including prevention of cross contamination

Quality of water can be ensured by providing certain minimum treatment for raw water such as filtering through sand bed, chlorine dozing followed by filtration through activated carbon column. Water treated in this fashion shall be tested for conformity to appropriate standards for

achieving safety of water. The supply lines and storage tanks of treated process water shall be cleaned as per the cleaning procedure for food contact surfaces once in a month.

Table 3: Recommended levels of available chlorine for different sanitation purposes

Purpose	Recommended levels of available chlorine content
Process water, glaze water and ice production*	< 2 ppm for EU approved plants and < 5 ppm for National standard plants
Hand dip water	< 20 ppm
Foot dip water	100 – 200 ppm
Water for sanitation of utensils, processing table, processing machinery, etc.	100 ppm
Water for sanitation of floor and wall	100-200 ppm
Water for sanitation of drain	250-500 ppm

*In case of process water and water for ice production higher level of chlorine to the tune of 10-15 ppm is recommended for water disinfection, provided the chlorine level shall be reduced to recommended residue level before water and ice is used for food processing.

Source: Codex, 1995

Surface finish, water resistance and cleanability of all direct and indirect food contact surfaces

All food contact surfaces shall be made of water resistant, smooth and washable material. This will ensure proper cleaning and prevention of dirt accumulation.

Regular cleaning procedure and cleaning schedule

The direct and indirect contact surfaces shall be cleaned as per the cleaning procedure before and after each shift of production. The best cleaning procedure will be wetting with water, removing all solid wastes, application of a nonionic detergent by scrubbing with the help of a clean brush, washing with potable water, sanitizing with chlorine water containing 50 ppm chlorine for 30 minutes and finally washing with potable water. Cleaning of all contact and indirect contact surfaces will prevent bacterial build up and contamination of the food handled.

Personal hygiene practice

The use of factory provided uniforms, scrubbing of hands, sanitizing of footwear, hand sanitizing etc as outlined under the provision for personal hygiene shall be followed to avoid contamination from workers. A list of

15 basic points related to personal hygiene has been drawn up by Thorpe (1992).

Regular cleaning and sanitizing of uniforms

Uniforms for all the workers such as the dress, head cover, face mask etc shall be washed and ironed on a single use basis. On no account dress used in one shift shall not be used for another shift even if it is items like apron. All such used dress shall be washed and ironed before a second use. There shall be adequate facility in tune with the number of workers for hand scrubbing, sanitizing, uniform washing & ironing, utensil washing etc. in the plant.

Protection of all contact surfaces from lubricants, chemicals and sanitizers (other than chlorine)

The production personnel shall see that all the food contact surfaces are not contaminated with inedible materials like lubricants, detergents and other chemicals. This very essential to ensure safety of the food handled in the plant, and the same is achieved by (i) providing separate storage areas for food additives and sanitizers, (ii) following approved procedure for use of chemicals and display of the same in areas of use, (iii) usage of only food grade chemicals or chemicals approved by CIFT or competent authority, and (iv) usage of chemicals only by trained and authorized personnel.

Exclusion of poisonous and toxic chemicals in processing areas

In any food processing plant there shall not be storage or use of any type of toxic or poisonous chemicals in food handling areas even for pest control. For pest control in food handling areas the permitted procedure is fumigation with formaldehyde followed by de-fumigation with ammonia only when there is an unusual fly population.

Exclusion of infected workers

Daily the entire workers shall be monitored for any kind of disease or open wounds. The workers shall also be taught to report to the management any such disease condition. Infected workers or workers with open wound shall be isolated from handling the material till they are cured of the problem.

Adequate toilet facilities

There shall be sufficient number of toilets and bath rooms in the factory commensurate with the number of workers. Standards say that

there shall be one toilet for each fifteen workers. All such toilets must be made fly proof.

Direction and procedure for movement of waste and edible materials

In all food processing plants the direction of movement of edible materials and waste generated shall be opposite to prevent cross contamination. Solid and liquid wastes are often neglected and are a cause for various kinds of pest and microbial build up and consequent contamination. Whereever possible the solid and liquid wastes must be collected separately for treatment and disposal. All waste water generated should be collected through proper pipe lines into the drain, with out any chance to spill on the floor as waste water on the will be a cause for microbial build up. All drain inlets and outlets shall be fitted with fly proof netting to prevent outflow of solid waste into the effluent treatment plant as well as prevention entry of pests into the processing facility. There shall be suitable receptacles for collection of solid wastes with a procedure for their periodic removal and disposal. To take care of sanitation and hygiene a package of practices have been developed by CIFT and the same was offered as training to thousands of fish handling people working onboard fishing vessels, in fishing harbours and fish processing plants.

Pest control

Common pest like flies, cockroaches, lizards and rodents find their way into the food processing area, even though birds and pets are rarely seen. Often these pests introduce hazards and filth into the material handled in the plant. To overcome this there shall be effective pest control all doors and chutes in the plant shall be fitted with self closing devices. All externally opening doors and chutes are to be fitted with automatic air curtains. Fly proofing of all windows, ventilators, drain outlets or all holes more than half a square inch with fly proof netting. To take care of isolated flies and rodents there shall be electronic fly catchers and rodent traps located at strategic points. However the fly catchers must be positioned away from food handling points. In case of visible fly population, fumigation with H-CHO, followed by de-fumigation with ammonia can be adopted.

Good laboratory practices for risk and hazard monitoring

The raw material quality, the process monitoring as per HACCP, The GMP the SSOP, Personal hygiene etc depend heavily on monitoring

certain physical, chemical or microbiological parameters. Consequently the success of all the above processes and procedures will depend on the facilities of the laboratory in the plant. In fact the laboratory shall have all test methods and testing equipments in tune with the following requirements:

- Use of approved methods. All the methods used by the lab shall be methods approved by national or international agencies, like BIS standards, EU Norms, US FDA Guides, Codex, AOAC etc. Under no circumstances unapproved procedures shall be used for monitoring any process or quality parameter.

- Use of calibrated instruments. In case of measurements like volume, weight, time, temperature, pressure etc the measuring instruments shall be subjected to periodic calibration with reference to national or international standards, before they are used for actual measurements. In case of weights and measures the Legal Metrology Dept and in case of other physical measurements calibration with reference to the standards whose accuracy can be traced back to the standards maintained at National Physical Laboratory, New Delhi or the International Standards kept at Paris.

- All laboratories will be using various chemical standards for estimation of several chemical parameters by different methods like titration, chromatography, spectrophotometry, etc. All such standards shall be certified reference materials (CRM) or certified analytical reagents. This will ensure accuracy and reproducibility of test results.

- Accreditation of labs by National and International agencies. All labs attached to food processing plants must be accredited by qualified assessors appointed by agencies like National Accreditation Board for Laboratories or International Laboratory Accreditation Conference to ensure that these labs have necessary facilities in terms of equipments, chemicals including certified reference materials, qualified personnel etc and necessary methodology to perform stipulated tests so that the results generated by the lab is dependable as well acceptable to the consumers.

- Record keeping. The lab shall keep all the records relating to production and quality assurance as per HACCP, SSOP, GMP etc and these records shall be available for review and audit for at least three years. Generally the records insisted are those outlined in HACCP plan form (CCP monitoring records, corrective action records and calibration records.), Hygiene and sanitation monitoring records, GMP records, ETP (Effluent Treatment Plant) records, raw material and finished product testing records. All these records shall be supported with appropriate procedures and schedule for ensuring as well as to counter check their adequacy.

GLP is relatively new area and CIFT has implemented several programmes for achieving good laboratory practices. Conducting proficiency testing and inter-laboratory calibration for testing laboratories and laboratories attached to factories are being done periodically. CIFT is also giving the much needed assistances for getting accreditation from agencies like NABL, BIS etc. To meet the requirements of sophisticated and expert analysis of various parameters CIFT also has set up facilities for calibrating weights and measures and temperature monitoring equipments along with several instrumentation facilities for chemical residue monitoring. The industries are using all these supports periodically to make the data generated by their laboratories accurate and dependable. All these facilities are operated and maintained by standard operating procedures.

Good personnel policy

All major events in food manufacture like sanitation, hygiene, processing and quality checks heavily relay on modern methods in science and technology. However, all the production and quality checks are performed by specific personnel, whose knowledge and skill will ultimately decide the safety of the product. So the personnel required for all these activities shall be suitably qualified and certified for the job assigned to them. Any lacuna in this respect will amount to compromising safety of the products. In fact there shall be qualified and certified personnel to monitor processing and quality checks in every production shifts with a stand by person to take over during unexpected personal emergencies. Products of a plant with such qualified, certified and alert personnel will never be a source of health hazards. This can be ensured by a good personnel policy consisting of recruitment of suitably qualified personnel in sufficient number, providing them periodic training necessary to upgrade and update their skill to meet growing demands in production, quality and marketing. The employees shall be oriented to modern developments through such trainings and shall be offered good service conditions to keep them alert, active and responsible. The operations of all these quality assurance programmes in production lines are designed to achieve quality and safety standards for fish and fishery products. The current standards in this respect (EEC, 1991) can be classified into four categories as detailed in Tables 4.

These guidelines can be incorporated in the day to day operations in seafood production. Educational video films on HACCP, SSOP and GMP are also available for effective communication of these concepts. Thus,

Table 4: Seafood quality standards

Quality criteria	Tolerance limits
Microbial quality	
TPC (cfu.g^{-1})	<5x10^5
Faecal *Streptococci* (nos.g^{-1})	<20
Faecal coliforms (nos.g^{-1})	<20
Escherchia coli (nos.g^{-1})	<20
Staphylococcus aureus (nos.g^{-1})	<100
Salmonella spp. (in 25 g)	Nil
Vibrio cholerae (in 25 g)	Nil
Listeria spp. (in 25 g)	Nil
Antibiotics	**MRL, ppb**
Chloramphenicol	Nil
Furazolidone	Nil
Neomycin	Nil
Tetracycline	100
Oxytetracycline	100
Trimetoprim	5.
Oxolinic acid	300
Nalidixic acid	Nil
Sulphamethoxazole	Nil
Heavy metals	**MRL, ppm**
Cadmium	0.5- 1.0
Lead	0.5- 1.0
Zinc	50
Copper	-
Mercury	0.5- 1.0
Pesticide residues	**MRL, ppm**
BHC	0.3
Aldrin	0.3
Dieldrin	0.3
Endrin	0.3
DDT	5.0

Source: EEC (1991); MRL: maximum permissible residue level

if there are proper implementation of HACCP, GMP, GHP, SSOP, GLP and good personnel policy, any food processing plant can achieve ISO 22000 food safety and quality standards, throughout the chain of food production, processing and marketing.

References

Anon (1982) The Principles of Design for Hygienic Food Processing Machinery, R.A. Campden Technical Memorandum 289, Campden Food Preservation Research Association, Gloucestershire, UK

Anon (1983) Hygienic Design of Food Processing Equipment, R.A. Campden Technical Manual No. 7, Campden Food Preservation Research Association, Gloucestershire, UK

Anon (1996) An Introduction to HACCP for Fish Processors Ed. II, Asean-Canada Fisheries Post Harvest Technology Project – Phase II, Singapore

Barker, J. and McKenzie, A. (1997) Review of HACCP and HACCP-based food control systems. In: Fish Inspection, Quality Control and HACCP: A Global Focus (Martin, R.E., Collette, R.L. and Slavin, J.W., Eds.), p. 73-81, Technomic Publishing Co. Inc., Lancaster, Pennsylvania

Codex (1995) Codex Alimentarius General Principles of Food Hygiene, Alinorm 95/13, FAO, Rome

EEC (1991) Commission Decision 91/493/EEC of 22 July 1991, Laying down the health conditions for the production and the placing on the market of fishery products, Official Journal of the European Communities No. L. 268/15

FDA (1980) Fish and seafood, Compliance Policy Guides (CPG) 7108.02-7108.25, Chapter 8, Food and Drug Administration, Public Health Service, Washington, DC

Hayes, P.R. (1985) Food Microbiology and Hygiene, Elsevier Applied Science Publishers, Barking, Essex, UK

Huss, H.H. (1994) Assurance of Seafood Quality, FAO Fisheries Technical Paper 334, FAO, Rome

ICMSF (1988) Microorganisms in Foods 4: Application of the Hazard Analysis Critical Control Point (HACCP) System to Ensure Microbiological Safety and Quality, International Commission on Microbiological Specifications for Foods, Blackwell Scientific Publishers, Oxford, UK: 357 p.

Imholte, T.J. (1984) Engineering for Food Safety and Sanitation, The Technical Institute of Food Safety, Crystal Minnesota, USA: 283 p.

ISO 22000 (2007) Food Safety Management Systems, ISO 22000 series, International Organization for Standardization, Geneva, Switzerland

Iyer, T.S.G. (1998) HACCP concept in seafood industry, In: Advances and Priorities in Fisheries Technology (Balachandran, K.K., Iyer, T.S.G., Madhavan, P., Joseph, J., Perigreen, P.A., Raghunath, M.R. and Varghese, M.D., Eds.), p. 185-193, Society of Fisheries Technologists (India), Cochin

Iyer, T.S.G. (2003) The HACCP system, an ideal food safety system, In: Seafood Safety (Surendran, P.K., Mathew, P.T., Thampuran, N., Nambiar, V.N.,

Joseph, J., Boopendranath, M.R., Lakshmanan, P.T. and Nair, P.G.V., Eds.), p. 473- 479, Society of Fisheries Technologists (India), Cochin

Katsuyama, A.M. and Strachan, J.P. (1980)(Eds.) Principles of Food Processing Sanitation, The Food Processors Institute,Washington, DC, USA

Lupín, H.M. (1997) FAO technical assistance on HACCP in the fishery Industries, In: Fish inspection, Quality Control and HACCP: A Global Focus (Martin, R.E., Robert L. Collette, R.L. and Slavin, J.W., Eds.), p. 35-48, Technomic Publishing Co. Inc., Lancaster, Pennsylvania

Milledge, J.J. (1981) The hygienic design of food plant, In: Proceedings 14, p. 74–86, Institute of Food Science and Technology, London, UK

MPEDA (1977) A Course Manual and Guide for Implementation of HACCP Principles and Pre-requisite Programmes with reference to US and EU Seafood Regulations, Marine Products Export Development Authority, Cochin, India

Mukundan, M.K (2003) Risk analysis of seafood for food safety In: Seafood Safety (Surendran, P.K., Mathew, P.T., Thampuran, N., Nambiar, V.N., Joseph, J., Boopendranath, M.R., Lakshmanan, P.T. and Nair, P.G.V., Eds.), p. 466-472, Society of Fisheries Technologists (India), Cochin

Nambiar, V.N. and Surendran, P.K. (2003) Microbial hazards in fish sold in retail markets of Cochin, In: Seafood Safety (Surendran, P.K., Mathew, P.T., Thampuran, N., Nambiar, V.N., Joseph, J., Boopendranath, M.R., Lakshmanan, P.T. and Nair, P.G.V., Eds.), p. 399 – 405, Society of Fisheries Technologists (India), Cochin

Santos, L.D., Carlos A. and Sophonphong, K. (1998) Fish inspection and HACCP: an overview, In: Proc. Workshop on Seafood Inspection, AGR/FI/RD(98)22, Organization for Economic Cooperation and Development, Paris

Santos, L.D., Carlos, A. and Hector M. Lupín, H.M. (1997) FAO's experience in HACCP training of regulatory and industry personnel, In: Fish inspection, Quality Control and HACCP: A Global Focus (Martin, R.E., Robert L. Collette, R.L. and Slavin, J.W., Eds.), p. 708-718, Technomic Publishing Co. Inc., Lancaster, Pennsylvania

Schantz, E.J. (1984) Historical perspective on paralytical shellfish poisoning, In: Seafood Toxins (Ragelis, E.P., Ed.), p. 99–111, ACS - Symposium Series 262, American Chemical Society, Washington, DC, USA

Shapton, D.A. and Shapton, N.F. (1991) Principles and Practices for the Safe Processing of Food, Butterworth-Heinemann, London, UK

Surendran, P.K (2003) Antibiotic Residues in seafood - a hazard, In: Seafood Safety (Surendran, P.K., Mathew, P.T., Thampuran, N., Nambiar, V.N., Joseph, J., Boopendranath, M.R., Lakshmanan, P.T. and Nair, P.G.V., Eds.), p. 543- 549, Society of Fisheries Technologists (India), Cochin

Taylor, S.L. (1986) Histamine food poisoning: toxicology and clinical aspects, CRC Crit. Rev. Toxicol. 17: 91-128

Thorpe, R.H. (1992) Hygienic design considerations for chilled food plants, In: Chilled Foods - A Comprehensive Guide (Dennis C. and Stringer, M., Eds.), Ellis Horwood. Ltd., Chichester, UK

Troller, J.A. (1983) Sanitation in Food Processing, Academic Press, New York

Wessells, C.R. and Anderson, J.G. (1992) Seafood safety assurances: implications for seafood marketing and international trade, URI/OSU Research Paper Series RI-103, University of Rhode Island, Kingston, Rhode Island, USA

Wessells, C.R. and Anderson, J.G. (1993) Consumer willingness to pay for seafood safety assurances: implications for seafood labeling and public policy, URI/OSU Research Paper Series RI-93-102, University of Rhode Island, Kingston, Rhode Island, USA

Wessells, Cathy R, Jeffrey Kline & Joan Gray Anderson. (1996). Seafood safety perceptions and their effects on anticipated consumption under varying information treatments. Agricultural and Resource Economics Review. April, pp. 12-21.

WHO (1984) Aquatic (Marine and Freshwater) Biotoxins, Environmental Health Criteria Series 37, World Health Organization, Geneva

WHO (1989) Report of WHO Consultation on Public Health Aspects of Seafood-borne Diseases, WHO/CDS/VPH/90.86, World Health Organization, Geneva