

Hygiene and safety of fish and fishery products



Published during the National Fisheries Development Board (NFDB), Hyderabad funded Skill development programme on 'Hygiene and safety of fish and fishery products' from 23/10/2018 to 25/10/2018



ICAR-Central Institute of Fisheries Technology (CIFT)
Veraval Research Centre
Matsyabhavan, Bhidia, Veraval-362 269, Gujarat



2018

Training manual

Hygiene and safety of fish and fishery products

Prepared by

Dr. Remya. S
Dr. C. O. Mohan
Dr. Ashish Kumar Jha
&
Dr. Toms C. Joseph

Edited and published by

Dr. C. N. Ravishankar



ICAR-Central Institute of Fisheries Technology (CIFT)
Veraval Research Centre
Matsyabhavan, Bhidia, Veraval-362 269, Gujarat



2018

CONTENTS

Sl. No.	Title	Page No.
1.	Importance of fish in the human diet	1
2.	Proximate composition of fish	2
3.	Bacteriology	4
4.	Onboard handling and preservation of Fish	7
5.	Post-mortem (After death) changes in the fish muscle	8
6.	Spoilage of fish and quality loss	9
7.	Fish spoilage indicators/indices	10
8.	Methods of prevention/Control of fish spoilage/Fish processing methods	11
9.	Spoilage and pathogenic bacteria	12
10.	Hygiene requirements when handling seafood	16
11.	Personal hygiene	17
12.	Structural, equipment and process requirements	19
13.	Checklist for fish processing facilities	21
14.	Checklist for operational hygiene requirements for safe seafood	22

Importance of fish in the human diet

- Fish is an exceptionally important component of the human diet, which provides essential nutrients of high bioavailability.
- The proximate composition in most fish is primarily water, protein, and lipid, which make up about 98 % of the total mass of the fish muscle.
- Fish protein is regarded to be of high nutritive value, due to its favourable content and balance of essential and nonessential amino acids.
- Fish, though an excellent and cheap source of high quality protein, but what makes fish a truly unique food is all the additional nutrients that it contains in significant amounts. These nutrients include essential fats, minerals and vitamins.
- Almost completely absent in the higher plants, highly unsaturated fatty acids (HUFAs) or polyunsaturated fatty acids (PUFAs) determine the dietary value of fish in human nutrition.

Why is eating fish healthy?

Eating fish, the high-protein, low-fat food, provides a range of health benefits. A clear correlation between fish intake and health and life expectancy has been established by studies and with a high per capita fish intake, worldwide, Japan has the highest life expectancy.

- ✚ *Omega-3 PUFAs (EPA and DHA)* are particularly important for human health, because they are required for fetal and infant growth, maturation and cognitive development and are known to be beneficial by counteracting the metabolic syndrome, obesity, diabetes, arteriosclerosis.
- ✚ It is the essential long-chain omega-3 fatty acid, *docosahexaenoic acid (DHA)* that is important for optimal brain development in children and *eicosapentaenoic acid (EPA)* that improves cardio-vascular health.
- ✚ Positive health effects have also been reported for fish *protein*. Fish contains more soluble protein than meat. The protein in fish is easily digestible and hence fish is a good nutritive food for children.
- ✚ Small sized fish species, when consume whole with heads and bones, is an excellent source of many essential *minerals such as iodine, selenium, zinc, iron, calcium, phosphorus, potassium, vitamins A and D, and several B vitamins*. The presence of fat soluble *vitamins (A, D, E and K)* in fish increases its nutritive value.

- ✚ Seafood is almost the only natural source of *iodine*, which is also a rich source of highly bioavailable *calcium and iron and zinc* are found in significant amounts.
- ✚ The unique nutritional composition of fish derives not only from fatty acids, amino acids and micronutrients (vitamins and minerals), but studies on other less well-known nutrients such as *taurine and choline* also show probable additional health benefits.

Proximate composition of fish

Proximate composition means composition of the major constituents/contents of the fish. They are **1. Water, 2. Protein, 3. Lipid/Fat and 4. Ash**

1. Water: 60-80 %, But, in Bombay duck fish (*Harpadon nehereus*) water content is high (90 %).

2. Protein: 15-25 % in fin fishes, 8-15 % in shell fishes

-Proteins are made up of 20 amino acids

-Essential amino acids: Amino acids which cannot be synthesised in human body

- Essential amino acids: VIP HALL MTT (Valine, Isoleucine, Phenylalanine, Histidine, Arginine, Leucine, Lysine, Methionine, Threonine, Tryptophan)

Protein Classification

a) Sarcoplasmic (Enzymic) protein: 20-30 %

-Examples: Myoglobin, Enzymes and albumins

-Pelagic fish (fish lives in the top water, near shore) has high content of Sarcoplasmic protein than demersal fish (fish lives in the deep bottom water, away from shore)

b) Myofibrillar (Contractile/Structural) protein: 65-75 %

-Examples: Myosin, Actin, Tropomyosin and troponins

c) Stroma (Connective tissue) protein: 3-10 %

-Examples: Collagen, Elastin

-3 % in teleosts

-10 % in elasmobranchs

-Difference between animal and fish meat: Animal meat is tough and hard while fish meat is soft and tender because animal meat contains high amount of stroma/connective tissue protein.

3. **Lipid** : 0.2-60 %

Fish classification: Lean, semi-fatty and fatty

Lean fish: less than 0.5 % fat

Semi-fatty:0.5-2 % fat

Fatty fish: more than 2 % fat

-When the fat content increases, the water content in fish body decreases

-Fats/lipids are fatty acid esters of glycerine

-Fatty acids: Two types, Saturated and unsaturated fatty acids.

-Essential fatty acids: 2% of total lipid. Examples: Linoleic, linolenic and arachidonic acid

-Fish is a source of highly unsaturated fatty acids (with two or more double bonds) called polyunsaturated fatty acids (PUFA)

-Fish contains w-3(omega-3) or n-3 polyunsaturated fatty acids PUFA

-n-3 PUFA have medicinal value

-Examples: EPA (Eicosapentaenoic acid, 20: 5, with five double bonds)

DHA (Docosahexaenoic acid, 22:6, with six double bonds)

4. **Ash**

-Ash is constituted by the minerals present in the fish

-Content: 0.4-2 %

- Fish is a valuable source of calcium, phosphorus, iron, copper and selenium.

-Saltwater fish have a high content of iodine.

Other components of fish body

1. Vitamins

-Fish in general is a good source of water soluble vitamin B

-Fatty fish is a rich source of Vitamins A & D

(Fat soluble vitamins: A, D, E, K

Water soluble vitamins: B group and C)

2. Carbohydrates

- Major carbohydrate in fish is glycogen (a polymer of glucose and stored in liver)

-Fin fish and crustaceans contain 0.1-1 % glycogen

-Molluscs contain high glycogen (1-7 %)

3. Non-protein nitrogenous compounds

-In addition to protein nitrogen, some non-protein nitrogenous compounds are present

-NPN fraction (non-protein nitrogen) constitutes from 9 to 18% of the total nitrogen in teleosts.

-Examples: **Free amino acids** (Eg: Glycine, Histidine and Taurine)

Nucleotides (Eg: ATP (Adenosine triphosphate))

Peptides

Guanidino Compounds: Eg: Creatine Phosphate. Quantitatively, the main component of the NPN-fraction is creatine.

Betains

Marine toxins (Eg: Saxitoxin)

Urea: less than 5 mg % in teleosts and shell fishes, 2 % in elasmobranchs

-In dead fish, urea is decomposed by bacterial enzyme into ammonia and carbon dioxide

Quaternary ammonium compounds (Trimethylamine oxide (TMAO))

-Fresh water fish doesn't contain TMAO

-TMAO contributes to the characteristic odour and flavour of marine fish

-Elasmobranchs have more TMAO than teleosts

-In dead fish, TMAO undergoes bacterial degradation and produces Trimethylamine (TMA)

-Content of TMA is an indicator of fish spoilage

-The amount of TMAO in the muscle tissue depends on the species, season, fishing ground, etc. In general, the highest amount is found in elasmobranchs and squid (75-250 mg N/100g) followed by cod (60-120mg N/100g), while flatfish and pelagic fish have the least.

Bacteriology

Bacteria: Microscopic organisms with single prokaryotic cell, which are found everywhere. They are so small that they are not visible without a microscope.

Most bacteria are *harmless* to people and healthy living fish and shellfish. Some bacteria are *useful* and give us products like yoghurt and cheese.

Shape of bacteria: Spherical (Coccus), Cylindrical (Rod shaped) and Spiral (Filamentous)

Size of bacteria: 0.5-100 micron in length and 0.5 to 2 micron in diameter. Each bacterium is a single cell and it takes about 500 million to fill a space the size of a pinhead.

Cell of bacteria (Cytology): Bacterial cell has an outer rigid semi-permeable *cell wall*, then a semi-permeable *cytoplasmic membrane*, then inside a soft gel like viscous watery solution called *protoplasm*. The outer cell wall of the bacterium protects it.

-Protoplasm contains organic/inorganic solutes, nucleus and ribosomes. Some bacteria have whip-like flagella, which help them to move about.

✚ Gram staining

-A thin bacterial film is kept on a glass slide

-Cover with a solution of *crystal violet (Primary stain, Violet colour)* for one minute

-Wash with water

-Add dilute *iodine (Mordant, which fixes the stain)* over the same film and keep for one minute

- Wash the slide with alcohol

-Pour *counter stain, safranine (Pink/red Colour)* over the film for half minute

-Wash with water

-Dry

Bacteria which retain violet colour- **Gram positive bacteria**

Bacteria which didn't retain violet colour and with red/pink colour-**Gram negative bacteria**

Gram positive bacteria: **Thick cell wall**

Gram negative bacteria: **Thin cell wall**

✚ Bacterial reproduction and growth

-Reproduction: Bacterial multiplication takes place by a process called **binary fission/transverse fission**.

- A single bacterium will 'grow' to a certain size and then split to form two smaller bacteria. This '**splitting**' is technically known as binary fission. These two smaller bacteria grow to full size and then split into four and then eight and so on.
- The bacteria don't grow much in size but their numbers multiply quickly. Under ideal conditions it could take 1 hour and 20 minutes to go from 1 to 16 bacteria. In other words, if conditions are favourable, most bacteria can double their numbers about every 20 min and some as quickly as every 10 min.

Growth of bacteria

There are different types of bacteria, which can multiply on almost everything so long as there's *food, water, warmth and time*.

- Some will multiply best in the cold;
- Some will multiply best in the heat;
- Some can multiply without oxygen and some can take it or leave it;
- Some will multiply in sea water and so on.

- Bacterial growth is influenced by environmental conditions and availability of nutrients
- Environmental conditions: Oxygen, Temperature, Salt, pH etc.

Bacteria will compete with each other for food, space etc. They all wait for conditions, which are more suitable to themselves than to other types of bacteria. When this happens, they can out-multiply the competition.

Effect of oxygen on growth

- Aerobic bacteria/aerobes: Requires oxygen for growth. Grow in the presence of oxygen
- Anaerobic bacteria/anaerobes: Can't grow in the presence of oxygen
- Facultative anaerobes: Can grow both in the presence and absence of oxygen

Effect of temperature on growth

Speed of multiplication of bacteria also depends on temperature. Keep bacteria either too cold or too hot so that they cannot multiply and you will keep them out of the **Danger**

Zone. The Danger Zone is from **5 °C to 63 °C**. This is the temperature range that most food poisoning bacteria like the best. If food is kept below 5 °C, then bacteria don't multiply too quickly. Above 63 °C, most food poisoning bacteria don't multiply at all.

-Psychrophiles: Cold loving bacteria. Grow at temp between 0-20 °C. Optimum temp is 15°C.

-Mesophiles: Grow at temperature between 20-45 °C. Optimum temp is 30- 37 °C.

-Thermophiles: Grow at temperature between 45-65 °C. Optimum temp is 55 °C.

Effect of pH on growth

- Optimum pH for bacterial growth is between 6.5-7.5

-Beyond this, either in acidic or alkaline range is unfavourable for bacterial growth

Effect of salt on growth

-Halophilic: Salt loving bacteria. They don't grow in the absence of salt. This kind of bacteria need salt concentrations higher than 20 percent.

-Halophobic: Bacteria which cannot grow, when salt concentration is higher than 6 percent

-Halotolerant: Bacteria which grow in salt concentrations higher than 6 percent and even up to saturation.

-Growth: The **lag phase** (No cell division takes place at this phase), the **logarithmic or exponential phase** (cells divide at a constant rate and this is the period of most rapid growth), **Stationary phase** (Number of cells remains constant) and **death phase** (Cell division ceases and cells begin to die in large numbers)

Onboard handling and Preservation of Fish

A lot of people handle the seafood before it is eaten. Each time a different person handles it there is a chance that more bacteria will be added to those already on the seafood. Given enough time, the seafood will spoil or 'go off', the bacteria causing the flesh to become soft and slimy, and a characteristic 'off' smell to develop.

Post-mortem (After death) changes in the fish muscle

✚ Glycolysis

In live fish: with the help of oxygen Glycogen is oxidized to CO₂ and water

After death

- Blood circulation stops
- Stoppage of supply of oxygen
- Aerobic oxidation of glycogen stops
- Anaerobic oxidation of glycogen leads to production of lactic acid
- Acid production leads to fall in pH

✚ Rigor mortis (stiffening of the muscle)

- Immediately after death, the fish is soft and texture is elastic to touch: **Pre-rigor Fish**
- After sometime, the muscle becomes hard and stiff and the whole body becomes inflexible and the fish is said to be in **rigor mortis: Fish In rigor**
- After lying stiff for some time, the fish gradually becomes soft again: **Post-rigor Fish**

✚ ATP degradation

- Adenosine triphosphate (ATP) to Adenosine diphosphate (ADP) to Adenosine monophosphate (AMP) to Inosine monophosphate (IMP) to Inosine to Hypoxanthine.
- IMP: Sweet flavour
- Hypoxanthine: Bitter flavour

✚ Hydrolytic changes (Autolytic)

- Degradation of tissue components by hydrolases enzymes

✚ Changes in fat (Autoxidation)

- Oxidation of tissue fat by atmospheric oxygen
- Primary products of autoxidation: peroxides and hydro-peroxides
- Secondary products of autoxidation: Aldehydes and ketones

Spoilage of fish and quality loss

Fish is a highly perishable food and spoilage is usually rapid, since fish allow microbial growth being highly nutritious, having high moisture content and a relatively neutral pH value. Spoilage reduces the shelf life/keeping quality of fish.

✚ Spoilage of fish: 3 reasons

- Microbial spoilage
- Chemical spoilage
- Enzymatic (Autolytic) spoilage

Microbial spoilage of fish/Action of bacteria on the chemical components of fish

It is bacteria which mainly cause seafood to lose quality after harvesting. We take the seafood out of the cold wet sea, where most bacteria will not easily multiply. On land it is warmer, and bacteria like the warmer temperatures. They start multiplying happily in and on the dead seafood.

1. Degradation of amino acids: Decarboxylation and Deamination

Amino acids contains carboxyl and amino group

-Decarboxylation: Removal of carboxyl group from amino acids using decarboxylase enzyme

Example: Conversion of amino acid Histidine into histamine, lysine into cadaverine

-Scombroid fish poisoning/Histamine poisoning: Scombroid fishes like tuna, mackerel etc. have high contents of histidine in their muscle. Histidine decarboxylase enzyme acts on histidine and produces histamine, which causes food poisoning.

-Deamination: Removal of amino group from amino acids. Ammonia is the product of deamination of amino acids. This causes strong ammoniacal odour in spoiled fish.

2. Reduction of Trimethylamine Oxide (TMAO)

- Bacteria reduces Trimethylamine Oxide (TMAO) to Trimethylamine (TMA)
- TMA contributes to the typical smell of marine fish

3. Action on Urea

- Urea in the flesh of elasmobranchs is converted to ammonia by bacteria

4. Microbial rancidification of fat

-Microbial enzyme lipoxidase acts on lipid/fat and results in formation of aldehydes and ketones

Spoilage leads to changes in appearance (colour), smell and taste. Spoiled food is usually easy to spot.

Comparison of fresh and spoiled fish

	Fresh Fish	Spoiled Fish
Skin	Slimy with natural colour and surface is shiny. Slime is clear, not white.	Non-slimy and colour faded
Texture	Firm, elastic (spring back when pressed), flesh cannot easily be separated from the bone	Loose, non elastic, flesh can easily be separated from the bone
Odour	Sea weedy or fishy	Off odour/ammonia-like odour
Gill	Bright red colour	Colour fades into brown/grey and finally yellowish with pungent smell
Eyes	Round, bright, full, clear/transparent and slightly bulging with a jet black pupil and translucent cornea	Red in colour, dull, cloudy, opaque and sunken with a grey pupil
Scales	Firm and strong, shiny and lustrous	Loose and easily detachable
Flavour	Sweet characteristic flavour	Un pleasant flavour
Colour	Bright colour	Dull colour

Fish spoilage Indicators/Indices

1. Total Volatile Base Nitrogen (TVBN)

-Concentration of volatile nitrogen compounds like Trimethylamine, ammonia etc.

-Upper acceptable limit: 30-35 mg %

2. Trimethylamine (TMA): Forms by decomposition of TMAO

- Upper acceptable limit: 10-15 mg %

3. **Ammonia:** Forms by decomposition of Urea
4. **Hypoxanthine:** Forms by decomposition of ATP
5. **Peroxide value:** Measures primary lipid oxidation product, peroxide
 - Upper acceptable limit: 10-20 milli equivalent O₂/kg of fish sample
6. **Thiobarbituricacid Value (TBA):** Measures malonaldehyde, secondary lipid oxidation product
 - Upper acceptable limit: 1-2 mg malonaldehyde/kg of fish sample
7. **K-Value:** Calculate freshness of the fish from the autolytic degradation products of nucleotides

Methods of prevention/control of fish spoilage/Fish Processing Methods

1. **Lowering temperature of the food** (bacteria cannot multiply well)
 - Chilling/Icing** (temperature near 0 degree Celsius (0-2 °C), but not below 0)
 - : At chilling temperature many bacteria become inactive, but psychrophiles/psychrotrophs may grow
 - : Shelf life of chilled stored fish-5 to 15 days
 - In a tropical climate, 1:1 ratio of ice and fish is customarily used
 - Types of ice: Block ice, Flake ice, Plate ice, Tube ice etc.
 - Freezing** (temperature below 0 degree Celsius (0- -20 °C)
 - : Long term method of preserving fish
 - : Freezing converts water into ice crystals and making water not available for bacterial action
 - : In a freezer, most bacteria will stop multiplying, but they will not die
 - : Shelf life of frozen stored fish-6 to 8 months
2. **Lowering water activity/moisture content of the food** (bacteria cannot multiply at all)
 - Drying:** Removing a considerable portion of water from fish by evaporation
 - Salting:** Reduces the availability of water for biological functions of the bacteria
3. **Heat processing/Thermal Processing**

Heating methods aim to kill off most or all of the bacteria and the spores. Bacteria usually prefer it warm and not cold, but make them too hot and they will die. Bacteria are destroyed or the number of bacteria is reduced in food by heat treatment.

-Cooking or hot smoking

Raising the temperature **above 74 °C** to cook the food will kill off most food poisoning bacteria (but will not destroy any spores).

Spores

There is a problem with the spores produced by some bacteria because spores can survive the high temperature conditions that would kill most bacteria. Spores have tough, heat resistant coats which will allow them to lie around, resting for a long time while conditions are too harsh. When conditions improve the coat splits and new bacteria emerge to multiply. Spores can often survive drying, disinfection, freezing and heat, so even efficient cleaning cannot remove all of them. Freezing food will not destroy them, and even cooking may leave some to survive and cause problems later. Spores need to be heated to higher temperatures and for longer times than bacteria, before they are killed.

-Canning (sterilises food through heat treatment, bacteria all killed off)

: The canning process heats the food to a high temperature for a long time to kill off the bacteria and spores in the food product which is in a sealed container. The sealed container prevents recontamination until the can is opened.

: Canned foods are heated to a high enough temperature and for long enough to kill off spores. That is why canned food lasts so long.

: Shelf life of canned fish-2 years

-Pasteurisation: Partial destruction of bacteria by application of heat

4. Other methods

: **Pickling** of fish products in vinegar slows down bacterial multiplication and prolongs shelf life.

: **Irradiation** is another method used to preserve fish and fish products. The radiation will kill bacteria, parasites and pests, but has little effect on spores and will not destroy toxins.

Spoilage and pathogenic bacteria

Most of the bacteria which cause *spoilage* changes, even if eaten, do not harm people.

The fish won't taste very nice but it won't make anyone ill. There are groups of bacteria,

which cause **food poisoning** and it's very important that these don't get near the seafood. Seafood contaminated with large numbers of these bacteria can taste and smell OK, but can still be very dangerous.

Poisoning bacteria are not found naturally on seafood. The types of bacteria, which cause illness, contaminate the seafood during handling by careless food handlers. Fish muscle usually contains no bacteria, so if it's cut with a knife or is in contact with an infected surface after cutting, the food poisoning bacteria may be the first arrivals. Poisoning is preventable if we keep food clean, cool, and free from contamination at all times during handling. Eating seafood, which contains poisoning bacteria, causes various types of illness ranging from an upset stomach to death in a small number of cases. Very old, very sick, or very young people are at the greatest risk from food poisoning bacteria. This is because they have a lower resistance to them.

Bacteria of public health significance

1. *E. coli*: Gram negative bacteria
2. *Salmonella*: Gram negative bacteria
3. *Shigella*: Gram negative bacteria
4. *Vibrio cholerae*: Gram negative bacteria. Rod shaped.
5. *Vibrio parahaemolyticus*: Gram negative bacteria. Rod shaped.

6. *Faecal streptococcus*: Gram positive bacteria
7. *Staphylococcus aureus*: Gram positive bacteria. Primary habitat is man. Incidence in fish is indicative of poor personal hygiene in fish handlers.

8. *Clostridium botulinum*: Gram positive bacteria
 - Produces a deadly toxin and the resulting food poisoning is called botulism
 - Botulism is a problem in canned foods, which are not properly sterilized
9. *Listeria monocytogenes*: Gram positive bacteria.
 - Causes listeriosis which causes still birth/abortion in pregnant women

Food poisoning bacteria

There are two main types of poisoning bacteria

1. Bacteria which cause poisoning by multiplying inside people
2. Bacteria which poison by producing a toxin (poison)

Bacteria which cause poisoning by multiplying inside people

- *Salmonella*: These bacteria are usually found in the gut of animals such as **chickens, seagulls, dogs and people**.

- They multiply on food, which has been contaminated after cooking. They multiply on foods where the cooking has not been long enough to kill them all.

- The bacteria are spread through the careless handling of contaminated and uncontaminated food.

- Food poisoning takes about a day to develop. It usually involves serious vomiting and diarrhoea.

Salmonella poisoning can be avoided by:

- ✓ Clean handling – no contact with contaminated objects such as hands, clothes, knives, pests etc.
- ✓ Keeping cooked and uncooked foods apart
- ✓ Thorough cooking and reheating

- *Listeria monocytogenes* is another food borne bacteria, which may be found in a variety of food products including soft cheeses and cold smoked salmon. Listeria is particularly important because it multiplies at temperatures just above 0 °C and will even multiply in some lightly salted products.

Bacteria which poison by producing toxin

- *Staphylococcus aureus*: These bacteria are commonly found in the human nose, on our skin and often in septic cuts.

- They are often found on badly cleaned equipment.

They multiply on food and as they multiply they produce a toxin that poisons the person who eats the food.

-*Clostridium perfringens*: It cannot multiply where there is oxygen but can survive fairly high temperatures by forming spores (it will multiply quickly between 15 °C and 50 °C) and produces a toxin which causes the food poisoning. Bad cooking practice is the main cause. The toxin isn't destroyed by high temperatures, so once produced even thorough cooking will not remove the toxin.

-*Clostridium botulinum*: It causes botulism poisoning, cannot multiply where there is oxygen. It is an uncommon, but often fatal food poisoning bacteria, and is usually only found in canned and vacuum packed products. Cooking will easily destroy the bacteria and toxin causing this kind of food poisoning but not any spores it has produced, so food products that are eaten without cooking pose the highest risk.

TPC: Total Plate Count (Total Aerobic Mesophilic Bacterial Count)

-Total number of aerobic bacteria which grow at mesophilic temperature

-Unit of TPC: cfu (colony forming unit)

Permissible Limit of Total Plate Count in fresh/frozen seafood? 5 lakh cfu/g

5×10^5 cfu/g (European Union regulation)

7 log cfu/g (ICMSF regulation)

Permissible Limit of Total Plate Count in cooked seafood? 1 lakh cfu/g

Permissible Limit of other bacteria in fresh/frozen seafood

E.coli- 20 cfu /g

Staphylococcus aureus - 100/g

Vibrio cholera, *Vibrio parahaemolyticus*, *Salmonella*, *Listeria monocytogenes*

– Should be absent in 25g

Faecal indicators: Indicator organisms of faecal contamination. Examples: Coliforms, *E.coli* and *Faecal streptococcus*

Killing Bacteria

There are various ways of killing bacteria. We can kill them with disinfectants, sanitizers and sterilisers. We can kill them with high temperatures or irradiation.

Hygiene requirements when handling seafood

Food hygiene simply means the practice of properly chilling, cooking, cleaning food and avoiding cross-contamination to prevent the spread of bacteria in food. To maintain hygiene, precautions have to be taken to keep the food safe and wholesome from harvest to consumption. It helps in achieving a level of cleanliness, which prevents disease and food poisoning from developing.

- Good Hygiene is essential for the safe handling and preparation of Seafood.
- The Personal hygiene of staff and the cleaning and disinfecting of equipment and the workplace is of the utmost importance to prevent the contamination of food by the person that handles that food.
- People who do not maintain an appropriate degree of personal cleanliness, who have certain illnesses or conditions or who behave inappropriately, can contaminate food and transmit illness to consumers.

Contamination

Contamination is presence of anything that shouldn't be there in food. This contamination can be biological, chemical or physical, for example bacteria, chemicals or physical material such as hairs and bits of insects.

Cross-Contamination

Cross-Contamination is the transfer of biological or chemical contaminants to food products from raw foods, food handlers, or the food handling environment.

Categories of Foods

- ✿ Foods are classed as High Risk/Low Risk or Medium Risk Foods.
- ✿ In determining the level of control that is required to protect the consumer from food borne illness, foods including food ingredients can be categorized into: High Risk, Low Risk and Medium Risk Foods

High Risk Foods-These are foods which are a potential source of pathogenic (disease causing) microorganisms and are either intended for consumption by the consumer without a cooking step prior to consumption, which is adequate to kill pathogenic organisms or foods which are intended for consumption by people with low immunity such as infants, the elderly and hospital patients.

Medium Risk Foods- These are foods which are a potential source of pathogenic microorganisms and are intended for consumption by the consumer, with a cooking step immediately prior to consumption, which is adequate to kill pathogenic microorganisms.

Low Risk Foods-These are foods not previously known to be a source of pathogenic organisms and in which harmful residues or chemicals have rarely been found.

High Risk Processing Areas are defined as all areas where high risk foods are exposed if the subsequent processing does not contain a step which effectively destroys all harmful microorganisms or areas where high risk foods are exposed after they have undergone a processing step which effectively destroys harmful microorganisms. Unprocessed food can cause contamination of processed food by personnel who can act as carriers.

Personal hygiene

: Everyone's body can be a source of a lot of bacteria.

: People are very dirty in the bacterial sense, even when they look clean and tidy.

: The best thing would be to get rid of all the bacteria. Since we can't, we just have to do the next best thing.

- Reduce the numbers as much as possible;

-Avoid spreading them around;

-Thoroughly clean your knives, equipment and working surfaces, which can stand harsh treatment;

-Avoid outside contamination from other sources;

-Proper hand washing at all times.

Hand washing

: The answer to dirty hands is, of course to wash them well and often, as a routine.

Extra hand washings are also needed in the following cases:

- Before handling food;
- Between food handling operations (to prevent different foods from contaminating each other through you);
- After using the lavatory and before leaving the washroom;
- After smoking, coughing, sneezing or using a handkerchief.

Washing hands **does not mean** a quick rinse and a wipe on the overalls.

It means using:

- Soap;
- Hot water;
- Nail brush;
- Drying in a hygienic manner, using disposable paper towels or hot air.

-It is also important to avoid instant recontamination from doors, or clothes or other surfaces such as fridge or chiller door handles.

- Bactericidal soaps/creams also can be used.

-Take a bath or shower each day.

- Hair should be shampooed every other day at least.

Hand Washing Procedure

- Wet the hands and apply soap
- Rub the hands to spread the soap over the hands
- Wash hands thoroughly. Start with palm to palm then interlacing the fingers.
- Wash the back of each hand with the palm of the other hand then each thumb clasped in the opposite hand and each wrist clasped in the opposite hand.
- Brush the nails and other areas, where dirt is difficult to dislodge
- Rinse hands and rub to check that all the lather has been removed. Rinse again and Dry thoroughly

Good health and good practice

- **Cuts, grazes, sores and boils:** All cuts, grazes, sores and boils to be completely covered by clean brightly coloured waterproof dressings.

- **Coughing, sneezing, nose blowing, spitting:** These all need to be avoided where food is being handled, because saliva and mucus can contain millions of poisoning bacteria ready to contaminate your food. Use of handkerchief or clean paper tissue is essential and hands must be immediately washed again.

- **Smoking:** Smoking involves frequent hand to mouth contact, so the hand is always contaminated with mouth bacteria including *Staphylococcus*.

- **Clothing:** Hygienic dress for food handlers starts with clean underclothes every day. Top clothing should be adequately covered by protective clothing. The reasons for this are to protect your own clothing from splashes and to prevent contamination of food from contact

with your everyday clothing. It is very important that outdoor clothing, especially shoes, are kept outside food rooms. It is also important that food handling clothes are not worn outside during tea and lunch breaks etc. unless you change into clean clothes before starting work again. Protective overalls should be changed at least every day and more often if they become obviously soiled. Plastic or rubber aprons and wellingtons should be scrubbed at least daily with hot water and disinfectant.

- **Head covering:** Hair should be enclosed in suitable headgear. This stops debris from head getting on food and it also stops contaminating hands from hair.

- **Jewellery, watches, nail varnish, and rings:** All jewellery, watches and rings harbour dirt and bacteria. Loose bits from these and flakes of nail varnish often end up in food products causing both physical and bacterial contamination, sometimes poisoning and usually complaints. Most of these things, including nail varnish, have cracks where bacteria can lodge and so must be kept away from food.

- **General health:** Sick people are likely to carry a lot more bacteria than usual. They can often be the ones that cause food poisoning. So, those who have diarrhoea, vomiting, septic cuts, boils, discharge from eye, ear or nose or have a bad cold should not handle food.

Structural, equipment and process requirements

Primary production

Landing site layout, including jetty design and construction:

- The design and size of landing site or vessel should provide adequate working space to allow hygienic performance of all operations including unloading, handling, marketing, processing, storage and transport and to facilitate the maintenance of quality of fish and fish products.
- The layout of landing site or vessel protects against the accumulation of dirt and water.
- The layout of landing site or vessel permits adequate cleaning and disinfection.
- Landing site fenced with lockable system to keep out animals, rodents and other pests.
- Landing site or vessel maintained in good repair and condition.
- Floor allows easy drainage of water.
- Sufficient lighting whenever necessary.

Equipment and contact surfaces:

- Equipment, containers and utensils that come into contact with fish at sea and on the shore are easy to clean and disinfect and are kept clean.
- Design of equipment, containers and utensils that come into contact with fish prevent build up of dirt, and facilitate good hygiene practice (GHP) and good icing practice.
- Facilities and equipment at sea and on shore are cleaned and disinfected at least immediately after using.
- Decks not contaminated with fuel, bilge water or other contaminants.

Provisions related to the hygienic handling of fish products:

- Parts of the premises at the landing site that are set aside for the storage of fishery products are kept clean, maintained in good repair and condition, and free from fuel or bilge water contamination.
- Fishery products are protected from contamination and from effects of weather conditions (sun, rain) as soon as possible after unloading from fishing vessels.
- Good icing practice used on board fishing vessels and on shore after landing.
- Fishery products chilled or re-iced as soon as possible after unloading from fishing vessels and time–temperature conditions facilitate maintenance of quality.
- Live fish and shellfish properly transported and handled.

Supply of water and ice:

- Available potable water in sufficient volume and with sufficient pressure.
- Use of potable water or clean seawater whenever fish are handled at sea or on shore.
- Ice produced from potable water.
- Ice stored in clean and well-maintained containers designated for this purpose.
- Sufficient ice available for use before and after landing.
- Safety of ice monitored.

Waste management:

- Containers available for solid waste.
- Adequate drainage system: the discharge does not contaminate the water intake system.

Personal hygiene and health:

- Facilities available for hand washing in sufficient numbers.
- Signs reading “no smoking, spitting, eating or drinking” at landing site.
- Adequate number of flush lavatories/toilets connected to an effective drainage system for large fishing vessels and landing facilities.
- Personnel assigned to do cleaning work.

Requirements before, during and after landing:

- Unloading equipment easy to clean, and kept in a good state of repair and cleanliness.
- Precautions observed to avoid contamination of fish during and after landing.
- No delays in unloading.
- The equipment used does not cause any damage to the fish.
- Vehicle exhaust fumes do not contaminate the fish during unloading and while on the landing site.
- If live fish are transported in cages or in semi-submerged vessels in rivers, there is a risk of contamination from chemicals, effluent and other pollutants.

Checklist for fish processing facilities

Lighting:

- Sufficient lighting in the area where fish is handled.
- Lights protected to prevent possible contamination of food by broken glass.
- Lights are easy to clean.
- Lights are maintained properly.

Ventilation:

- Adequate ventilation inside processing areas (no condensation is visible on walls and ceilings).
- No bad odour in processing areas.
- Good extraction of moisture facilitated.

Cold-storage compartments:

- Equipped with an easy to check temperature-recording device (automatic recording thermometer).
- Thermometer-sensor installed in proper place.
- Adequate cleaning and storage methods.
- Capacity sufficient to keep fish at appropriate temperature (at or below -18°C).

Storage facilities:

- Raw materials, finished products, and non-food items (e.g. packing materials, chemicals) stored in separate rooms.
- Proper methods of storage (enough space, pallets, clean and tidy storage areas, etc.).
- Inspection checklist for contact surfaces and equipment requirements.

Contact surfaces:

- Constructed of light-coloured, smooth, non-absorbent and non-toxic materials for easy cleaning and disinfection.
- In sound condition, durable and easy to maintain.
- Structures and joints of smooth construction and tight for easy cleaning.

Containers:

- Containers protect fish from contamination.
- Containers allow for easy drainage of water.

Equipment and utensils:

- Designed in such a way as to prevent contamination of the products.
- Designed for easy cleaning and to prevent accumulation of dirt.
- Installed so that it can be accessed from all sides for cleaning and servicing (properly sealed to the floor if permanently sited).
- Kept in good order, repair and condition so as to minimize any risk of contamination.

Freezing and cold storage;

- Sufficient capacity of freezing equipment to lower temperature rapidly to achieve a core temperature of not more than -18°C .
- Cold-store refrigeration capacity sufficient to keep fish temperature at or below -18°C (-9°C if in brine).
- Cold stores equipped with a temperature-recording device that is easy to consult.

Source: FAO (2009)

Checklist for operational hygiene requirements for safe seafood

Traceability and product recall system

- Origin and specifications of raw material supplied.
- Composition, packaging, distribution, validity, and storage conditions notified.
- Lot identification code providing suitable traceability.

Supply of water, ice and steam

- Water available as necessary, distribution diagram available.
- Automatic treatment system adapted and operational.
- Monitoring of residual chlorine content, if added.
- Surveillance of contamination indicators in place. Sampling plan should be adequate and systematically followed.

Water

- Adequate supply of potable water with sufficient pressure and volume.
- Clear distinctions between potable and non-potable water pipes.
- Water quality monitored regularly.

Ice

- Ice is produced from potable water / clean water.
- Ice stored in clean and well-maintained containers designated for this purpose.
- Safety of ice monitored.

Steam

- Steam in contact with fish and shellfish made from potable water.
- Steam available at sufficient pressure.

Staff facilities

- Adequate changing facilities with separate changing rooms for men and women in different processing areas.
- Sufficient flush toilets that are connected to an effective drainage system.
- Lavatories located away from production, packing and storage areas.
- Adequate number of washbasins for cleaning hands provided with running water and non-hand operated water taps, and materials for cleaning hands and for hygienic drying.
- Staff facilities properly maintained and kept clean.

Hygiene control programme

- Appropriate cleaning and disinfection plan implemented by trained workers.
- Persons who use physical, chemical and biological means for cleaning and disinfection properly trained.

Waste management

- Offal and other waste regularly removed from production areas, so that no accumulation occurs.
- Sufficient closable containers for offal and other waste, clearly identified and made of easy-to clean and impervious materials with suitable structure.
- Adequate provision made for the storage and disposal of food waste and waste materials.
- Waste stores designed and managed in such a way as to enable easy cleaning, and to prevent ingress of animals and other pests.
- Drainage channels designed to ensure that waste does not flow from a contaminated area towards or into a clean area.
- All waste eliminated in a hygienic and environmentally friendly way, and not constituting a direct or indirect source of contamination.

Pest control systems

- Good hygienic practices employed throughout to avoid pest infestation.
- Pest control programme available that prevents access, eliminates harbourage and infestation, and establishes monitoring, detection and eradication systems.
- Physical, chemical and biological agents for pest control are properly applied by qualified personnel.
- Rodenticides, insecticides, disinfectants and any other toxic substances stored in premises or cupboards that can be locked.
- Toxic products cannot contaminate the fish products.

Raw materials and semi-processed products

- Procedures available that prevent acceptance of raw materials and ingredients that would make the final product unfit for human consumption.
- The cold chain continuously maintained during processing and transport.
- Use of good icing practice.
- Melt water does not remain in contact with the products when containers are used for the dispatch or storage of unpackaged prepared fresh fishery products stored in ice.

Personal hygiene and health

- Persons working in a fish handling area maintain a high degree of personal hygiene.
- All people entering the area where fish is handled are provided with suitable, clean and protective clothing (uniform, aprons, rubber boots, gloves, and hairnet).
- Protective clothing cleaned by the company.
- Medical examination periodically carried out on workers handling fish.
- Workers who could contaminate the products excluded from handling fish and fishery products.
- Workers handling fish wash and disinfect their hands each time before resuming work.
- Workers keep their fingernails short, clean and unvarnished.
- Any wounds covered with waterproof bandages.
- Smoking, spitting and eating are prohibited in production, packaging and storage areas, and workers follow these rules.
- Workers trained in and follow the hygiene instructions.
- First-aid assistance or first-aid cabinet available.
- Medical personnel available when factory is working.

Wrapping and packaging of foodstuffs

- Suitable material used for wrapping and packaging of food products.

- Materials used for wrapping and packaging stored and managed in a hygienic way.
- Wrapping and packaging operations carried out in such a way that the product is not contaminated.
- Re-used packaging materials are easy to clean and disinfect

Training

- All personnel including temporary workers are appropriately trained before starting the work.
- Workers supervised throughout by trained and experienced staff.

Source: FAO (2009)