Fish Hygiene and Microbiology

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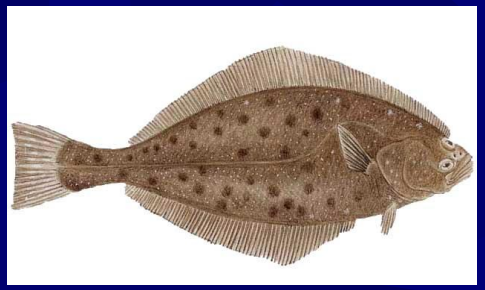
Introduction

- Fish and other seafood are very important sources in covering a large part of the protein demand for humans in developed and developing countries. The term **seafoods** include finfish, shellfish (Mollusca and Crustacea) and any other form of fresh or marine **animal** life that can be used for human consumption.
- With more than 30,000 known species, fish forms the biggest group in the animal kingdom that is used for the production of animal-based foods. Only about 700 of these species are commercially fished and used for food production.

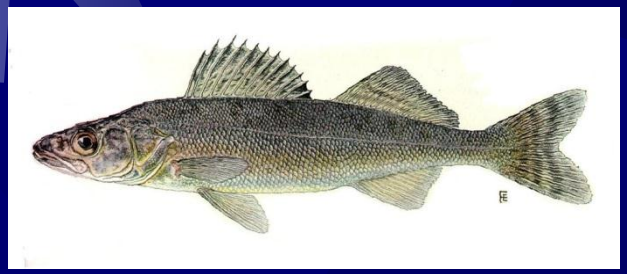
Fish

Carp

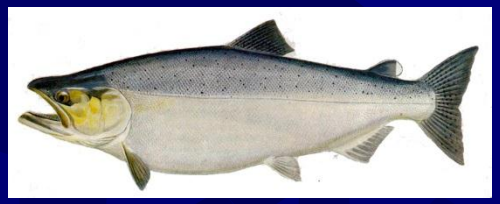


Halibut الهلبوت

Herring



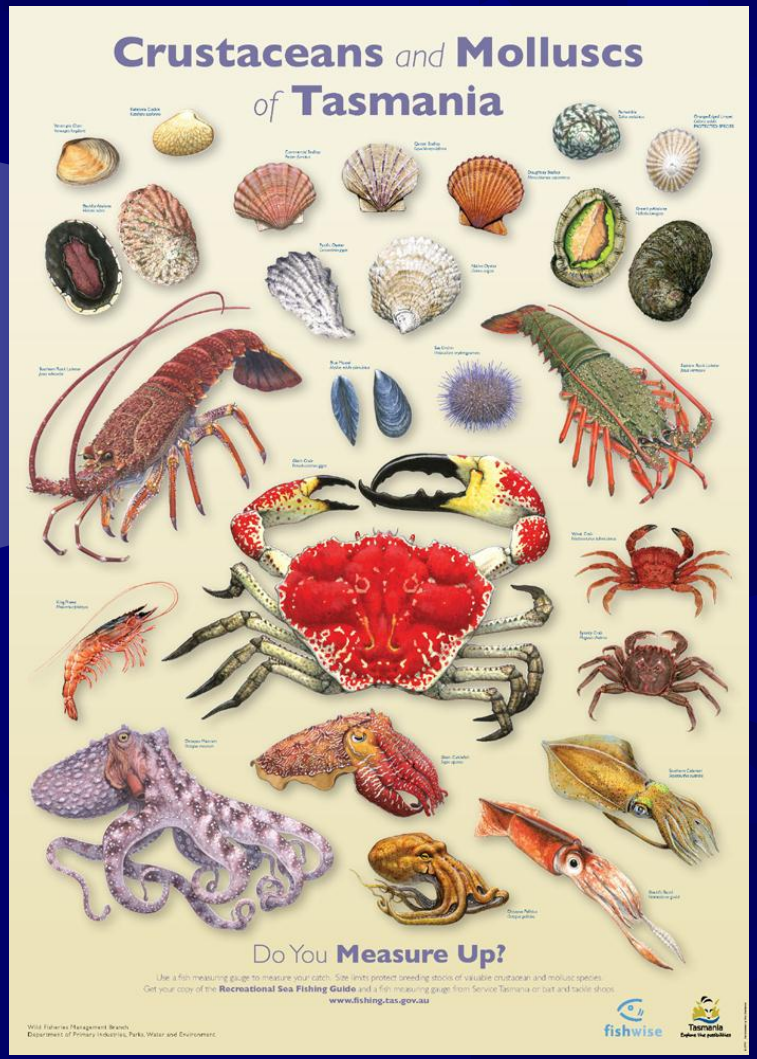
Pike سمك الكراكى



Salmon

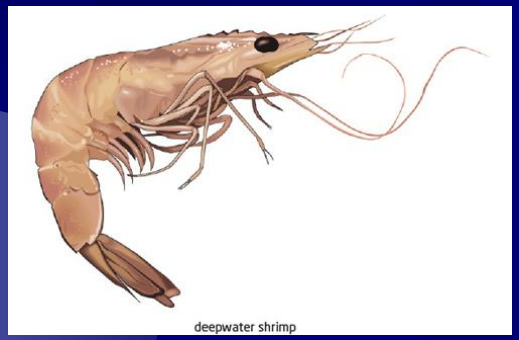
Tuna

Fish and Shellfish



- Types of…
  - Shellfish
    - Crustaceans
      - Have long bodies and jointed limbs
      - Covered with a shell
        - Crabs, crayfish, lobsters, and shrimp
    - Mollusks
      - Have soft bodies covered by rigid shell
        - Clams, mussels, oysters, scallops, and squid

Shellfish



Shrimp

Lobster
سرطان البحر

Oyster

Scallops

Crab

Crayfish جراد البحر

Squid الحبار

Seafood in the Animal Kingdom

Kingdom	Subkingdom	Branch (Phyllum)	Class	Order	Examples
Animal	Metazoa	Arthropoda	Crustacea	Decapoda	Prawn
					Crab
					Hermit crab
		Mollusca	Gastropoda (Snails)	Trochoidea	Trochus Fasciolaria
			Lamellibranchia (Bivalvia)		Pincteda vulgaris
			Cephalopoda	sepiida	Sepia
				Octopoda	Octopus
		Vertebrata	Pisces	Chondrichthyes	Shark
				Osteichthyes	Tilapia catfish

Chemical composition

- Major components (Protein, fat & Moisture)
- Minor components (CHO, minerals & vitamins)
- **The average composition of fish flesh is:**
- 15 – 24% protein 0.1– 22% lipid
- 0.1 –3% carbohydrates
- 66 –84% water
- 0.8 – 2% inorganic substance

	Moisture %	Protein %	Fat %
Fish	66-84	15-24	0.1-22
Beef	70-75	18-22	1.5-13
Poultry	70-74	20-23	3-6
Milk	87	3.6	4

Fish protein

- High biological value, rich in essential amino acids.
- Can be digested easily (1-2 % connective tissue of total protein), while it is 10-13 % in warm-blooded animals.

- **Fish could be divided into:**

1. Low protein content (< 17%), e.g. catfish, Pacific oysters
2. High protein content (17-20%), e.g. Herring, Mackerel, Salmon and Eel
3. Very high protein content (> 20%), e.g. Tuna, Shrimp and Roe.

Fish protein

- Muscle protein is composed of sarcoplasmic protein which in located in muscle plasma, myofibrillar protein which constitutes the main structure of muscle fibers and connective tissue contains stroma.

- **Sarcoplasmic protein:**

- **30% of the total protein**
- . It composes of water soluble proteins called myogen (myoglobin, albumin, and enzymes).
- These enzymes include glycoltic, hydrolytic enzymes and various proteinases
- The content of Sarcoplasmic protein in fish meat varies with species, but is generally higher in pelagic fish than demarsal one.

Fish protein

- **Myofibrillar proteins:**

- **60 – 70% of the total protein**
- . Myofibrillar proteins are the proteins that form myofibril which contain myosin, actin and regulatory protein such as tropomyosin, troponin, and actinin.
- Fish meat contains a larger percentage of myofibrillar protein than mammalian skeletal muscle

Fish protein

- **Stromal proteins:**

- **0.4 – 3% of the total protein**
- . Collagen or elastin or both are the main component of stromal protein. Collagen can't be extracted by water, acid or alkaline solution, but converts to water-soluble gelatin by moist heat, while elastin is very resistant to moist heat
- Fish collagen contains **more essential amino acids and less hydroxyproline** than that of red meat.

Non-protein nitrogenous (NPN) Compounds

- 9 –18% of the total nitrogen in teleosts and up to 40% in cartlgenous fishes.
- they are water soluble low molecular weight, nitrogen containing compound of non-protein nature.
- The major component in NPN fraction are volatile bases such as ammonia, trimethyle amine oxide (TMAO), nucleotides, free amino acids, amines, creatnine, creatine, purine bases and urea in case of cartilaginous.
- During postmortem changes TMAO is converted to TMA by action of bacterial enzyme which is said to be the source of fishy odour

Fish Lipids

- Fish lipids have high content of long chain, polyunsaturated fatty acids of the n–3 series, "omega 3 polyunsaturated fatty acids" (such as docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA)).
- highly susceptible to oxidative rancidity.
- The cholesterol content of fish muscle is generally low (35 mg/100 g).
- **Fish could be divided into:**

1. Lean fish (<1%), e.g. Cod.
2. Low fat content (1-5%), e.g. Trout and Mullet
3. Medium fatty fish (> 5-10 %), e.g. Catfish and Tuna and Salmon
4. High fatty fish (> 10%), e.g. Herring, Eel and Mackerel

Moisture content

- **Fish are divided content into:**

1. Low water content (< 70 %), e.g. Eel, Mackerel and Salmon
2. Medium water content (70 – 80 %), e.g. Catfish and Shrimp
3. High water content (> 80 %), e.g.: Cod, Haddock and Oysters

Minor components

1- Carbohydrates:

- <1-2 % in fish, 5 % in some Molluscan spp.

2- Vitamins: varies according to diet

- Fish is the most important natural food source of vitamin **D**.
- Fish and shellfish are very good source of vitamin **B6.**

3- Minerals:

- Fish is the only major natural source for selenium and iodine.
- They contain considerable amounts of Ca and P.

Factors affecting fish composition

- Species
- Anatomical variation
- Seasonal variation
- Age
- Sex
- Fish Diet
- Wild or aqua-cultured fish

Rigor mortis

(Postmortem changes in muscles and its conversion into meat)

- Rigor mortis is a state of reaction occurs after slaughter 'death' as a result of excessive muscular contraction and exhaustion of oxidative enzymatic system and accumulation of metabolic products 'lactic acid' resulting in coagulation of the muscle protein action myosin where the muscles and joints become stiff known as post-mortem rigidity or setting of the carcass. This condition developed in from cranial to caudal and dissolved in the same manner
-

production of ATP from the oxidation of glucose

1. Glycolysis: 1 glucose $\rightarrow$ 2 ATP + 4 H + 2 pyruvate
2. Oxidative decarboxylation: 2 pyruvate $\rightarrow$ 20 H + 6 CO_2
3. Oxidative phosphorylation: 24 H + 6 O_2 $\rightarrow$ 36 ATP + 6 H_2O

Postmortem changes in fish
I- Rigor Mortis

- **Rigor mortis** is the postmortem muscular stiffness, which is caused by the formation of permanent linkages between the actin and myosin because the ATP was depleted, and the anaerobic glycolysis leading to lactic acid accumulation and muscular pH reduction.
- Starts: 1-7 h after death
- Peak: 5-20 h after death
- Duration: 30-120 hrs in slaughtered fish, 32-93 hrs in suffocated fish
- **Rigor Mortis in fish is not different in principles from that in other animals However, there are fish-specific issues**
- **In general, fish muscles are characterized by its low contents of glycogen and hence the drop in the pH is small**

Factors affecting rigor- mortis in fish

- **Fish species:** Some species take longer than others to go into full rigor. **The difference is attributed to differences in their chemical composition**. Whiting goes into rigor very quickly and may be completely stiff in one hour after death. Several other species may require much longer time. In general, the onset of RM in fish may vary from about 10 min to several hours after death (1-7 hours is a good estimate(
- **Fish size:** Small fish usually go into rigor faster than large fish of the same species

- **Physical condition of the fish:** The less a fish is nourished before capture, the shorter will be the time it takes to go into rigor; this is because there is little glycogen reserve in the muscle. The same is for spent females after spawning as well as for starved fish whereas glycogen reserves may be depleted
- **Handling stress:** The greater the stress fish has experienced through handling prior to capture and death, the lesser are its muscle reserves of glycogen and the onset of rigor merits becomes rapid and so the duration of rigor. This leads to meat of poor texture and a shorter shelf life. On the other hand, the later rigor mortis begins and the longer it lasts, the longer are the storage life of the fish
- Temperature at which fish is kept is perhaps the most important factor that determines the onset and duration of rigor. The higher the temperature, the sooner rigor begins the faster it ceases, and the greater will be the toughness of fish when it is cooked and eaten

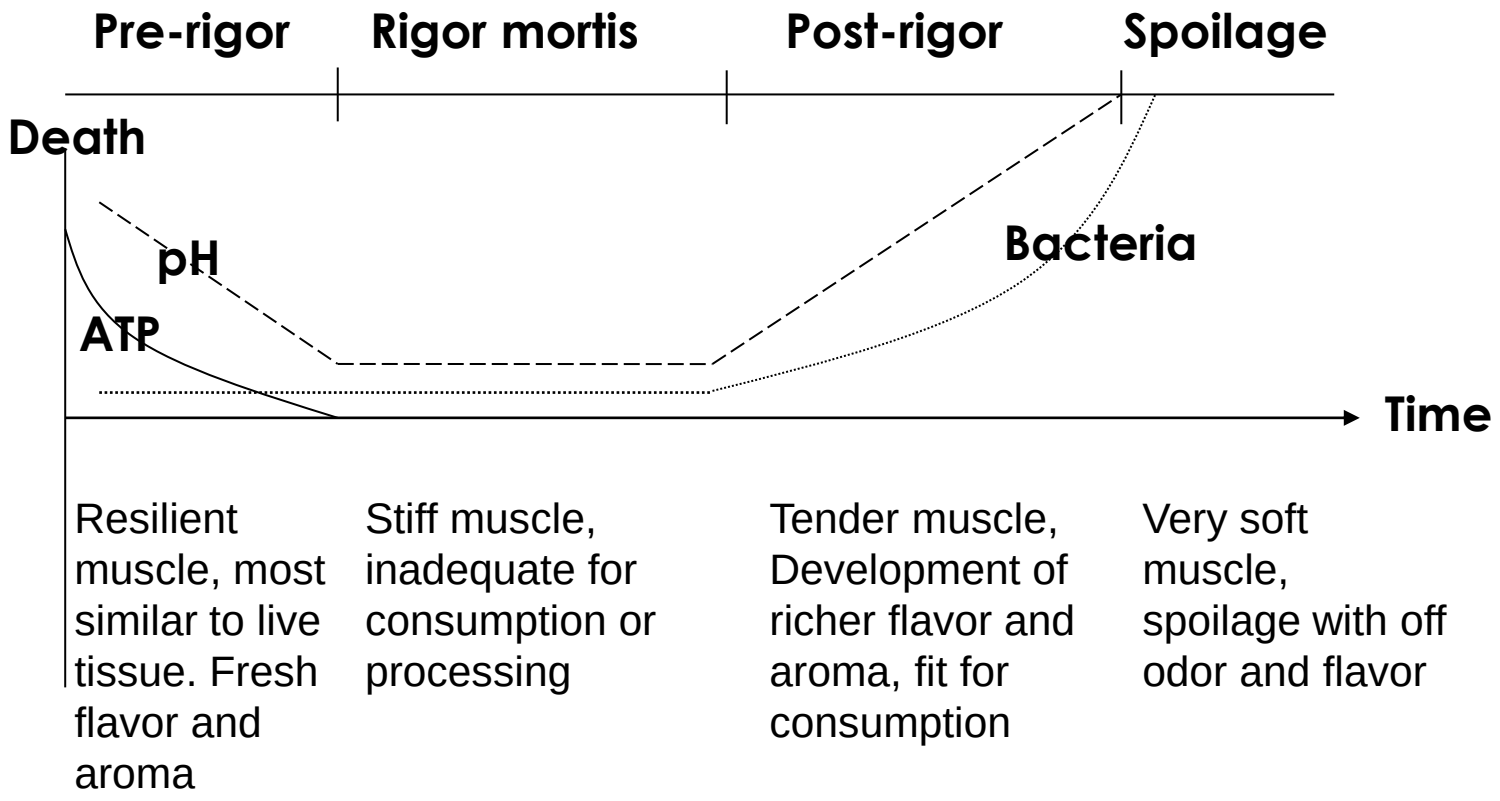
II. Reduction of pH

- The Initial pH of fish muscle (immediately after death): 7.05 - 7.35
- The ultimate pH of fish muscle (after onset of rigor mortis): 6.2-6.5.
- The fish with the lowest ultimate pH also has the greatest chance of dripping (due to reduced water holding capacity) causes losing of moisture, which leads to the organoleptic condition known as "chalkiness".

Chalky Halbuit

- Chalky Halibut is a fairly common condition which leaves the meat white, opaque, and a little mushy. While raw it appears as though it has been cooked. And after it is cooked the meat is soft and falls apart.
- The condition tend to occur in warmer months and due to struggling by fish on harvesting.
- The condition makes the fish of lower quality..

Schematic representation of the postmortem changes occurring in fish muscle



The Technological Significance of Rigor Mortis:

- Major importance when fish is filleted before or after rigor. In rigor the fish body will be completely stiff, the filleting yield will be very poor and rough handling can cause gaping. If fillets are removed from the bone pre-rigor the muscle can be contracted freely and the fillets will shorten following the onset of rigor. If the fish is cooked pre-rigor the texture will be very soft and pasty. In contrast the texture is tough but not dry when the fish is cooked in rigor, while cooking during post-rigor the flesh will be firm succulent and elastic. Both whole fish and fillets frozen pre-rigor can give good products if they are carefully thawed at a low temperature in order to give rigor mortis time to pass while muscle is still frozen.

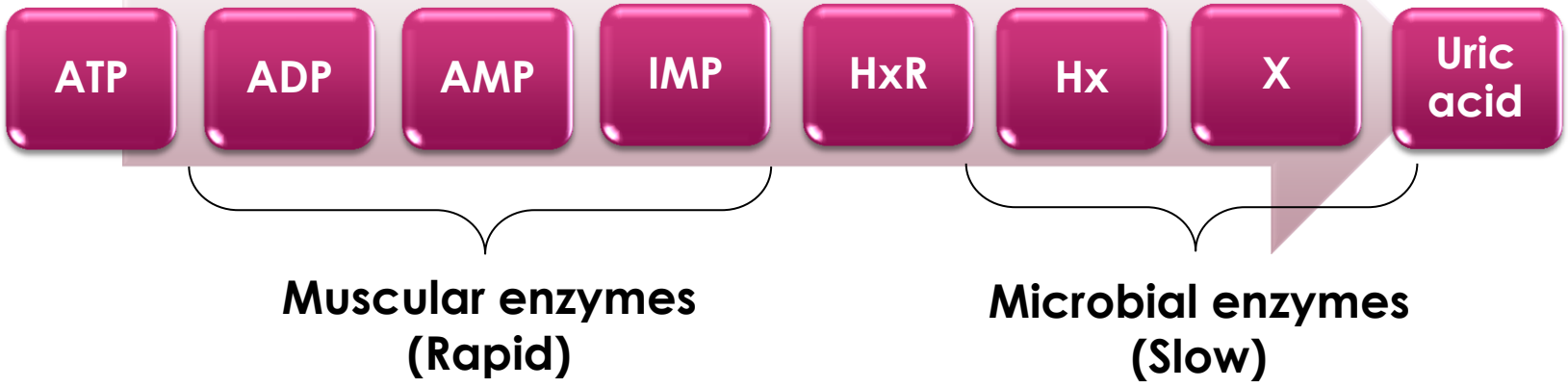
Fish Spoilage

- **Fish spoilage:** loss of freshness or breakdown of the chemical structure of fish muscle (protein, fat …etc) into simple undesirable compounds with offensive odour and taste due to physical, chemical or microbial causes.
- **Types of fish spoilage:**

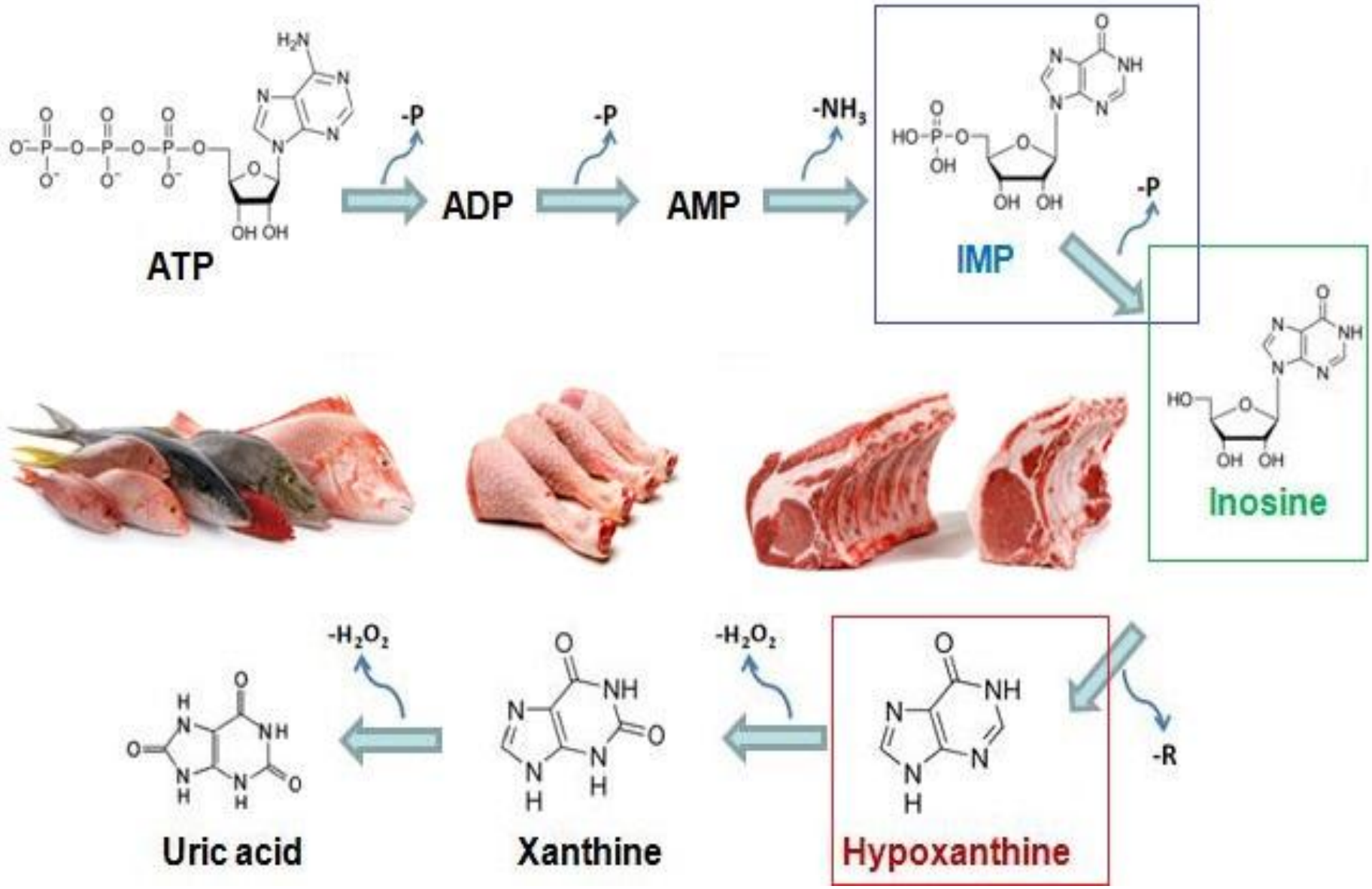
1. **Enzymatic spoilage (autolysis)**
2. **Microbial spoilage**
3. **Oxidative rancidity**

1- Enzymatic spoilage (autolysis)

- Naturally, large number of enzymes present in the fish flesh, during life they are engaged in normal processes such as muscular contraction and relaxation. While after death they involved in destructive processes.



$$\text{K-value (\%)} = \frac{[\text{HxR}] + [\text{Hx}]}{[\text{ATP}] + [\text{ADP}] + [\text{AMP}] + [\text{IMP}] + [\text{HxR}] + [\text{Hx}]} \times 100$$


ATP
-P
ADP
-P
AMP
-NH3
IMP
-P
Inosine
-R
Hypoxanthine
-H2O2
Xanthine
-H2O2
Uric acid

2- Microbial spoilage

- **Sources of fish contamination:**

1. **Endogenous sources:** gut, gills….etc. (e.g. Vibrio, Micrococci, Serratia, Aeromonas, Pseudomonas, Bacillus, Clostridium, Lactobacilli…..).
2. **Exogenous sources:** catching tools, boat decks, nets, handlers, ice, washing water, other vehicles and utensils ……..etc. (e.g. coliforms, staphylococci and salmonellae ….).

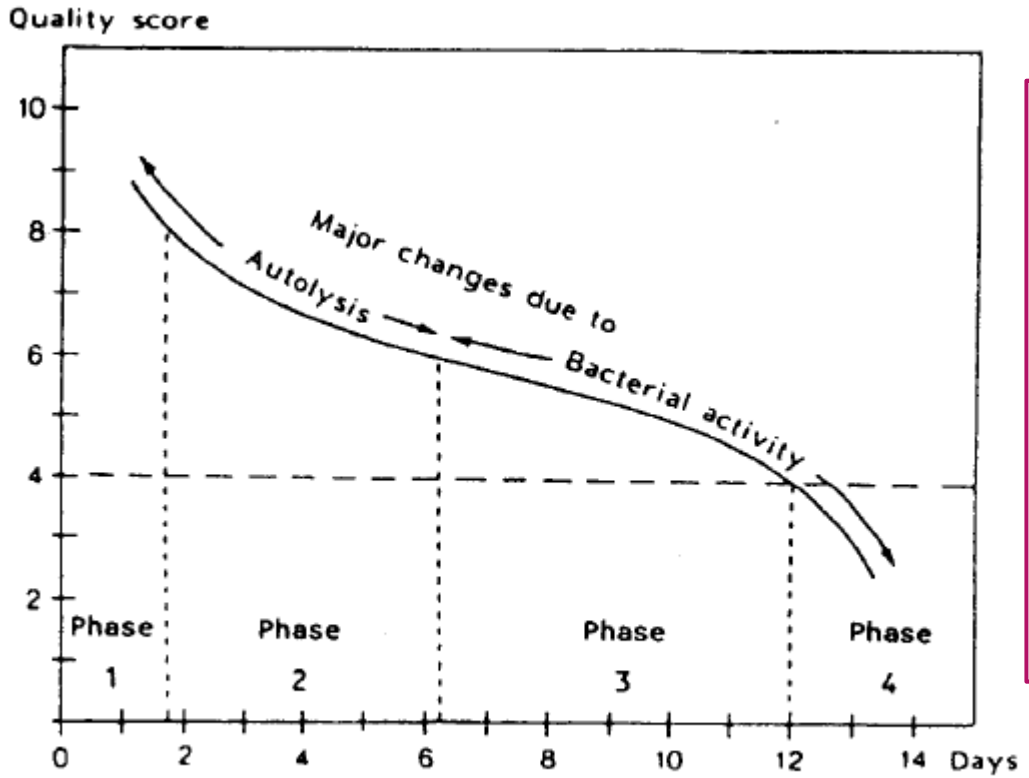
- **Signs:** changes in odor, color & consistency.
- The end products of protein degradation are:

1. **Indol** and **skatol** are responsible for off odor.
2. **Ammonia** and **TMA** are responsible for alkaline pH (6.2 -6.6 to 7.5-8)

3- Oxidative rancidity

- Fish is characterized by a high content of unsaturated fatty acids so it is more subjected to oxidative rancidity by atmospheric oxygen, leading to oily, rancid or paint odor due to aldehyde and ketone-like compounds produced from shorter chain fatty acids.
- It likely occurs in fatty fish than lean one.
- Oxidative rancidity is usually followed by hydrolytic rancidity by lipolytic microorganisms.

Changes in the eating quality of fish



. Changes in the eating quality of iced (0°C) cod (Huss 1976).

- In the first phase, the characteristic taste of the species is developed.
- The decrease of quality in the second phase is caused by autolysis and in the third phase by bacteria.
- While in the fourth phase the fish is inedible.

Why fish flesh is more perishable than other meats?

	Property	Condition
1	High level of polyunsaturated fatty acids	High rate of oxidative rancidity
2	Highly active muscular and gut enzymes	High rate of autolysis
3	Weak reduction in flesh pH after rigor mortis	High rate of bacterial growth in fish flesh

Factors affecting rate and kind of deterioration

1. **The kind of fish**
2. **The condition of fish when caught**
3. **The kind and extent of contamination of fish flesh with bacteria**
4. **Storage temperature**

METHODS OF QUALITY ASSESSMENT OF FISH

- 1. Sensory methods
- 2. Biochemical and chemical methods
- 3. Physical methods
- 4. Microbiological methods

SENSORY METHOD

- Sensory evaluation of food is defined as the scientific means of quantifying and interpreting the variations in food characteristics (odour, taste, tactile, appearance) by using human senses of sight, smell, taste, touch.
- Objectives seafood sensory tests, based on certain attribute of raw fish (skin, eyes, gills, texture, etc.), are the most commonly used methods for quality assessment of raw whole fish in the inspection service and fishing industry.

SENSORY METHOD

- There are several grading methods used to assess freshness in fish and fish products such as:

a) The European Union scheme

b) The quality index method

c) The torry scoring system

(a) European Union scheme

- In this scheme, three grades of freshness are established: E, A and B, corresponding to various stages of spoilage. E (Extra) is the highest possible quality, while below B is the level where fish is considered unfit for human consumption. The criteria of EU scheme for different species such as whitefish, redfish, anglerfish, are given below in the table:

CRITERIA	Freshness Category		
	Extra	**A**	**B**
Skin	Bright,iridescent pigment or opalescent ,no discolouration	Pigmentation bright but not lustrous	Pigmentation in the process of becoming discoloured and dull
Skin mucus	Aqueous, transparent	Slightly cloudy	Milky
Eyes	Convex,black,bright pupil,transparent cornea	Convex and slightly sunken, black,dull pupil	Flat,opalescent cornea, opaque pupil
Gills	Bright colour,no mucous	Less coloured, transparent mucus	Brown/green becoming discoloured, thick opaque mucus
Peritoneum on gutted fish	Smooth,bright,difficult to detach from flesh	Slightly dull,can be detached from flesh	Speckled, comes away from flesh
Smell of gills and abdominal activity	Seaweedy smell	No smell of seaweed, neutral Smell	Fermented ,slightly sour
Flesh	Firm and elastic,smooth surface	Less elastic	Slightly soft, less elastic

The torry scoring system

- The scoring system starts with 10 and declining. Ten (10) is the highest score for newly caught fish, 7 is in the neutral range, 6 is at the 'borderline', and 3 or lower score is considered spoiled. Customers generally reject them when it is down at the 6 score or lower.
- The most used scale for evaluating the freshness of cooked fish is the Torry-scores.

Biochemical and chemical methods

1) **Trimethylamine (TMA):** derived from TMAO in Marine fish (> 10-15 mg/100g indicate decomposition).
2) **Total volatile basic nitrogen (TVB-N):** widely used in all species (30 - 35 mg N/100g flesh indicates apparent decomposition).
3) **Hypoxanthine (Hx):** more complicated tech. for early stages of loss of freshness. value of 7-8 micro moles/g is considered spoiled
4) **K-value %**
5) **Peroxide value (PV):** for the first stage of rancidity (mlmol /kg flesh), measure hydroperoxide produced due to oxidation.
6) **Thiobarbituric acid reactive substance (TBA-RS):** mg MDA (malondialdehyde) /kg flesh, > 2 mg/ kg indicates rancidity.

$$\text{K-value (\%)} = \frac{[\text{HxR}] + [\text{Hx}]}{[\text{ATP}] + [\text{ADP}] + [\text{AMP}] + [\text{IMP}] + [\text{HxR}] + [\text{Hx}]} \times 100$$

$$\text{K-value (\%)} = \frac{[\text{HxR}] + [\text{Hx}]}{[\text{IMP}] + [\text{HxR}] + [\text{Hx}]} \times 100$$

- K < 20%: very fresh fish, suitable to be consumed raw.
- 20 < K < 40%: fish considered fresh to be consumed after cooking.
- K > 40%: fish inadequate for consumption.

c. Physical methods (Torrymeter.)

- The change in electrical properties is not caused directly by bacterial action or other spoilage mechanism, but the instrumental readings on iced fish can be correlated with the stage of spoilage, as measured by sensory methods or by one of the non -sensory methods already described.
- The instruments can be used only on whole fish or fillets with skin. Frozen fish, when thawed, give no response to the meter and this can be used as a basis for checking whether fish have been previously frozen.

Extension of fish shelf-life

- **Shelf-life:** is defined as the maximum period of time during which the quality attributes (odor, flavor, color and texture) of fresh food are retained.
- **Methods:**

1- Chemical antimicrobials and antioxidants

- Examples: lactic acid, ascorbic acid, benzoic acid, acetic acid, sodium benzoate, sodium ascorbate, potassium sorbate, sodium lactate.

Extension of fish shelf-life - continued

2- Natural preservatives: by using natural substances of antimicrobial or antioxidant nature such as essential oils and herbal extracts, this could be applied also by dipping or spraying. Examples: rosemary, thyme oil, thyme extracts (thymol and carvacrol), lemon juice, cinnamon.

3- Superchilling: This method is used by storage of fish in a temperature between chilling and freezing, mainly below 0 °C.

4- Vacuum (VP) and modified atmospheric packaging (MAP)

- Modified atmosphere packaging (MAP) involves the replacement of air by other gases, usually CO_2, N_2 and O_2, whereas vacuum packaging (VP) involves the removal of atmospheric air.
- Gases concentrations in MAP are usually varied according to kind of fish; (as in case of fatty fish, 60% CO_2 and 40% N_2 are used without O_2 to avoid fat oxidation), while 60 % CO_2: 30 % N_2: 10 % O_2 are the most common gases concentrations used for non-fatty fish.

2. Freezing

- Freezing process can be applied for either whole fish or fish fillets. Freezing temperature is – 18 °C, and frozen fish can be stored for up to 6 months without deterioration.
- **Glazing:** this techniques means application of a layer of ice on the surface of frozen fish, (which may be pure fresh water, seawater or fresh water contains antimicrobial substance). This done by immersing the fish in water before freezing then placed in the freezer to freeze the water layer, this step is repeated for several times.

Hazards Associated With Fish and Fishery Products Consumption.

- **Biological Hazards:**

1- Bacteria

1. Fish and fish products are susceptible to all common food poisoning organisms (Extrinsic bacteria) as well as to some that are unique to aquatic environment (Intrinsic bacteria) as *Listeria monocytogenes*, Vibrio species, *Clostrdium botulinun* and *Areomonas hydrophilla*

2. *Intrinsic bacteria*

- ***Listeria monocytogenes***)
- ***Vibrio parahaemolyticus***
- ***Vibrio vulnificus***
- ***Clostridium botulinum***
- ***Aeromonas hydrophila***

Extrinsic Bacteria

- ***Staphylococcus aureus***
- **Salmonella**
- **E.coli**
- ***Clostridium perfringens***
- ***Campylobacter jejuni***

Viral hazards
Hepatitis A virus

- Hepatitis A virus contaminate aquatic environment as a results of sewage pollution. Raw shell fish and cross-contamination from raw to cooked fish is the main root of infection,
- **implicated sea food:** Both raw and steamed clams, oysters, mussels **Symptoms** begin within 2 – 6 hours of exposure to the virus, as weakness, fever, malaise and abdominal epigastric pain. Infected individuals finally become jaundice, with low mortality rate

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Norwalk Virus (Noro virus)

- **implicated sea food:** clams, raw and steamed oysters and cockles
- **Symptoms:** nausea, vomiting, diarrhea, abdominal cramps and occasionally fever in humans. Symptoms of gastroenteritis usually begin within 12 - 72 hours of consuming contaminated food.
- **control the infection**: Proper cooking of fish, preventing cross-contamination of cooked fish in both viruses.

Parasitic Hazards

- The presence of parasites in fish is very common, but most of them are of little concern with regard to economics or public health. However, more than 50 species of helminth parasites from fish and shellfish are known to cause disease in man

- Raw, undercooked fish, cold-smoked fish, lightly salted fish, unfrozen fish, marinated fish and sushi are the main implicated items in parasitic infestation.

1- Anisakis simplex

- **implicated sea food:** It's a nematode worm, commonly called herring worm. Anisakiasis (the illness) is caused by the accidental ingestion of larvae of *Anisakis simplex* and is associated with the eating raw, undercooked and cold smoked fish
- **Symptoms:** severe abdominal pain, sometimes accompanied by nausea, vomiting, and occasionally fever(larvae invade the gastric and intestinal mucosa) 1- 5 days after ingestion of infected fish.
- **Prevention:** killing the larvae before eating the fish, but this doesn't guarantee the hyper immune reaction to the parasite proteins.

2- Diphyllobothrium latum

- It is a cestode worm, infect freshwater fish (Tilapia). It needs two intermediate host, fish become the second intermediate host by consuming infected crustaceans.
- The adult worm lives in the intestine of a variety of fish-eating mammals (including humans)
- **Symptoms:** The most cases of human Diphyllobothrium infection (Diphyllobothriasis) are asymptomatic. However, some individuals experience abdominal pain, diarrhea, constipation and occasional megaloblastic anemia.

3- Heterophyes heterophyes

- It is a minute trematode worm and needs two intermediate hosts to complete its life cycle. Parasitic infestation (heterophyiasis) of man caused by encycted metacercaria of *Heterophyes heterophyes* through consumption of raw or under cooked and lightly salted fresh water fish or brackish fish (tilapia and species mugil))

- As the infective stage could survive low salt concentration. Disease in man include: intestinal discomfort, colicky pain and diarrhoea in heavy infestation

4- Opisthorchis felineus or Cat liver fluke

- It is a termatode worm and needs two intermediate hosts to complete their life cycle. They infest the bile ducts, gall bladder and pancreas of cat, dog, pig, and man (definitive host)
- (Opisthorchiasis) occurs through consumption of under cooked fresh water fish. Most infections are asymptomatic. In mild cases, manifestations include abdominal pain, diarrhea or constipation. Symptoms can be more severe, hepatomegaly, jaundice and malnutrition may be present
- Heating of raw fish to 65-70°C or freezing fish intended to be eaten raw to at least -35°C for 15 hours or -20ºC for 7 days are sufficient to kill parasites.

Chemical Hazards

- Environmental Contamination
- heavy metals
- pesticides
- dioxins
- organtion compounds
- radionuclid
- Chemicals used in Aquaculture
- Biological Toxins (Biotoxins)
- Scombrotoxin
- Allergens

Environmental contamination

1-Heavy metals

- Heavy Metals are metals naturally occur in varying amounts such as iron, copper, cobalt and zinc are essential in small quantities for the healthy growth of human and animals. Others, such as mercury, lead and cadmium have no known biological role.

- Mercury, released in less toxic inorganic form through natural sources (e.g., volcanoes, mineral erosion) and human activities (e.g., coal combustion, paper processing, mining operation and waste incineration).

- It's converted to more toxic organic form, methyl mercury, by bacteria in freshwater and marine sediments.

Chemical hazards

- . Methyl mercury is taken up by aquatic organisms and accumulates to significant high levels especially in large predatory fish such as tuna and swordfish.
- No adverse health effects in fish have been recorded. Controversially, mercury in fish poses human health hazards, for the developing fetus, children and adults.
- Neurological symptoms which include, mental disturbance, ataxia and impairment of gait, speech and hearing

Pesticides

- . Pesticides such as cyclodienes, toxaphene, hexachlorobenzene, and others are substances used for protection of plants
- Fish and shellfish harvested from waters subject to wastewater discharges (fresh water,, and near-shore coastal waters) are exposed to varying amounts of pesticides rather than that from the open ocean. Pesticides used near aquaculture operations may also contaminate fish.
- the authority should classify harvesting waters according to their degree of pesticides contamination into permitted, permitted with restrictions and not permitted

Organotin compounds

- Trialkyl and triaryl tin are compounds have been increasingly used as biocides and antifouling paints because of their excellent ability to prevent marine organisms from becoming encrusted on ship bottoms and culturing nets
- it could be found, in cultured fish and in bay or inshore fish and shellfish
- organotin compounds exert adverse effects on the marine fauna even at low concentrations, so the use of these compound should be restricted.

Dioxins

- They are environmental pollutants. They are dangerous and persistent organic pollutants. Once dioxins have entered the body, they endure a long time because of their chemical stability and their ability to be absorbed by fat tissue, where they are then stored in the body (half life: 7-11 years)

- The chemical name for dioxin is: 2,3,7,8- tetrachlorodibenzo para dioxin (TCDD). The name "dioxins" is often used for the family of structurally and chemically related polychlorinated dibenzo para dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). Certain dioxin-like polychlorinated biphenyls (PCBs) with similar toxic properties are also included under the term “dioxins”.

Dioxins (sources)

- Dioxins are mainly by products of industrial processes but can also result from natural processes, such as volcanic eruptions and forest fires

- Dioxins are by products of a wide range of manufacturing processes including smelting, chlorine bleaching of paper pulp and the manufacturing of some herbicides and pesticides. uncontrolled waste incinerators (solid waste and hospital waste) are a major source of environmental realse.

- Although formation of dioxins is local, environmental distribution is global.. The highest levels of these compounds are found in some soils, sediments and food, especially dairy products, meat, fish and shellfish. Very low levels are found in plants, water and air.

Dioxins (Expousure)

- **Short-term exposure** of humans to high levels of dioxins may result in skin lesions, such as chloracne and patchy darkening of the skin, and altered liver function
- **Long-term exposure**: impairment of the immune system, the developing nervous system, the endocrine system and reproductive functions
- **Chronic exposure** of animals to dioxins has resulted in several types of cancer. However, TCDD does not affect genetic material and there is a level of exposure below which cancer risk would be negligible.
- The developing fetus is most sensitive to dioxin exposure and also the newborn.
- individuals at rist: 1- high consumers of fishes and 2- occupations (e.g., workers in the paper industry, in incineration plants)

Prevention and control of dioxin exposure

- Proper incineration of contaminated materials (850-1000^{o}C)
- Prevention or reduction of human exposure is best done via source-directed measures, i.e. strict control of industrial processes to reduce formation of dioxins as much as possible.
- protecting the food supply is critical (90% of human exposure is due food).
- Food contamination monitoring systems.

Radionuclides

- Human-induced radioactivity in fish may be caused by leakages from nuclear reactors, reprocessing plants and by fall-out resulting from nuclear explosions and by disasters such as the Chernobyl accident in 1986
- The most important radionuclides that may accumulate in the food chain are strontium-90 (^{90}Sr) and caesium-137 (^{137}Cs)
- Fish from lakes which received high amounts of fall-out from the Chernobyl emission, show activities exceeding 10,000 Bq kg-I, which makes the fish unfit for consumption.
- Compared to warm-blooded animals; the biological half-life of this radionuclide in fish is much longer and increases with decreasing water temperature, resulting in biological half-lives of 4 to 5 years or perhaps even longer.

Chemicals used in Aquaculture

- Purposes: diseases treatment, growth and reproduction improving or sedative during transportation. It could be carcinogenic, allergenic or lead to antibiotic resistance.
- These chemicals could be grouped into:
  - Treat and prevent diseases: Chloramphenicol, Fluoroquinolones, Oxytetracycline and Nitrofuran.
  - Control of parasites: Malachite Green , Formalin solution, Acetic Acid, Hydrogen Peroxide, Magnesium Sulfate and Sodium Chloride.

Chemicals used in Aquaculture

- Enhance reproduction and growth: Chorionic Gonadotropin and Oxytetracyclines
- Osmoregulation & relieves stress: Potassium Chloride and Sodium Chloride
- Tranquilization : Sodium Bicarbonate and Carbon Dioxide gas.
- Enhance egg hatchability: Sodium Sulfite, Urea and Tannic Acid.
- Improve color in salmon fish: Astaxanthin and Canthaxanthin

Control of aquaculture drugs

1) Each received batch of fish must be supported with a certificate of proper drug usage.
2) Periodical examination for drug residues.
3) The producer should conduct HACCP plan or any other quality assurance system for drug usage in the aquaculture.
4) On-farm visits to review drug usage before receipt of the product,

Biotoxins

- Biotoxins are toxic substances of biological origin accumulated in certain marine species.
- They classified into two groups

1- Toxins which are produced by certain marine algae like paralytic shellfish, diarrhetic shellfish, neurotoxic shellfish, amnesic shellfish poisoning and ciguatera. Where the toxins are produced by certain species of naturally occurring algae when bloom under favourable conditions

Biotoxins continued bivalve filter feeding (freshwater mussel).mp4

- Filter-feeding molluscan shellfish (clams, oysters, mussels and scallops) accumulate the toxins when utilizing toxic algae as a food source. As the conditions become less favourable, the bloom subsides and with time, shellfish rid themselves of toxin and are once again safe to eat.

2- Toxins which are naturally occurring in certain species of fish that do not involve marine algae, like Tetrodotoxin, Gempylotoxin and Tetramine

Biotoxins continued

Amnesic Shellfish poisoning (ASP):

- The toxin produced is domoic acid
- Symptoms:
- Early stages: intestinal distress.
- Severe ASP can cause a facial grimace or chewing motion, short-term memory loss and difficulty breathing and death can occur.

Biotoxins continued

Diarrhoeic shellfish poisons (DSP)

- They are produced by dinoflagellates of the genera Dinophysis and Protocentrum.
- They are soluble in non-aqueous solvents and comprise a group of seven polyethers, the best characterized being okadaic acid and its methyl derivative
- Symptoms: Gastroenteritis with rapid recovery

Biotoxins continued

Neurotoxic Shellfish poisoning

- Symptoms begin within three hours of consuming contaminated shellfish. Symptoms include: tingling of the face that spreads to other parts of the body, cold-to-hot sensation reversal, dilation of the pupils.
- Less commonly: prolonged diarrhea, nausea, poor coordination, and burning pain in the rectum, with low mortality rates.

Biotoxins continued

Paralytic Shellfish poisoning (PSP)

- They are produced by dinoflagellate algae of the genera Alexandrium, Gonyaulax and Protogonyaulax,
- The primary toxins include the carbamate toxins and the sulfocarbomoyl toxins.
- Symptoms usually begin within 30 minutes of consumption contaminated shell fish. Begin with numbness, burning or tingling sensation of the lips tongue, and fingertips. This leads to general muscular incoordination of arms, legs and neck
- . Severe cases of PSP can result in respiratory paralysis and death.

Tolerances and methods

Toxin	Tolerance	Method of analysis
Ciguatera	control not possible	No reliable method
PSP	80µg/100g	Mouse bioassay, HPLC
DSP	0–60µg/100g	Mouse bioassay, HPLC
NSP	any detectable level/100g is unsafe	Mouse bioassay
ASP	20µg/g domoic acid	HPLC

3. Ciguatera poisoning

- Causative agent: It is caused by eating the flesh of a wide variety of carnivorous reef fish(barracuda, grouper, jack, and snapper) and shellfish inhabiting shallow waters in or near tropical and sub-tropical areas. These fishes themselves are not toxic but become toxic due to feeding on small herbivorous fishes which feed on a tiny marine organism called a dinoflagellate (Gambierdiscus toxicus) which itself contains the toxin that is not destructed by cooking.

- Symptoms. gastrointestinal and neurological symptoms usually appear within 24 hours or less form consumption contaminated fish. Gastrointestinal symptoms, which usually persist for 12 hours, include: diarrhea, abdominal pain, nausea and vomiting. While the most common neurological symptoms include: impaired skin sensations, vertigo, ataxia, myalgia. Neurological symptoms may recur intermittently with gradually diminishing severity for a long as six months. The mortality rate of ciguatera ranged from 7-20%.

Tetrodotoxin (Puffer fish poisoning)

Healthy Living Deadly Poisonous_ Hidden Risks in Fish and Shellfish.mp4

- puffer fish (fugue or blow fish) contain potent toxin in their liver, gonads and skin called tetrodotoxin
- It acts on both the central and peripheral nervous systems.
- Symptoms usually begin within 10 minutes of consuming puffer fish. represented by numbness and tingling of lips, tongue and inner surfaces of the mouth, followed by weakness, paralysis of limb and chest muscles and death can occur within 30 minutes.

Poisoning by spoiled fish (Scombroid fish poisoning)

- Causative agent: It was believed that scombroid poisoning was due to consumption of spoiled fish flesh from the family Scombroid (e.g. Mackerel, Tuna) which contains high levels of histamine produced by bacterial histidine dehydrogenase enzyme activity on histidine amino acid presents in fish flesh.
- Incriminated bacteria are Morganella morganii, Proteus spp., Hafnia alvei and Klebsiella pneumoniae.
- Symptoms: It is a mild disease; incubation period is very short (few minutes to few hours) and duration of illness is short. The most common symptoms are cutaneous such as facial flushing, urticaria, edema, but also the gastrointestinal tract may be affected (nausea, vomiting, diarrhea) as well as neurological involvement (headache, tingling, burning sensation in the mouth).

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Physical hazards

- It is an injury caused by foreign object in fish and fish products.
- These objects can be categorized into metallic objects and non-metallic objects. Metallic objects are further divided into ferrous metals and non-ferrous metals.
- Hard or sharp foreign objects in fish and fish products may cause laceration and perforation of tissues of the mouth, tongue, throat, stomach and intestine as well as damage to the teeth and gums.
- Examples: metal (Metal ties , catching hoocks, blades,…….)
- Glass: in using glass contianers

Fish and Shellfish

- Buying Fish and Shellfish
  - Judge appearance, aroma, and touch
    - Fish
      - Shiny skin and glistening color
      - Clear full eyes
      - Bright red or pink gills
      - Mild, fresh aroma like the ocean or seaweed
      - Skin should spring back when pressed

Fish and Shellfish How To Peel And Devein Shrimp.mp4

- Buying Fish and Shellfish
  - Live clams, oysters, and mussels
    - Shells tightly closed, moist, and intact
      - Tap and should close
  - Scallops
    - Look moist but not liquid
    - Fresh ocean smell
  - Live lobsters and crabs
    - Dark bluish-green until cooked and then turn red
    - Live active with legs moving
    - Tail curls under when picked up
  - Shrimp
    - Deveined
    - Sold without intestinal tract


THANK
YOU
GRACIAS
ARIGATO
SHUKURIA
BOLZÏN
MERCI
BÏYAN
SHUKRIA
DANKSCHEEN
TASHAKKUR ATU
SUKSAMA
MEHRBANI
GRAZIE
JUSPAXAR