Fish:
Science and technology

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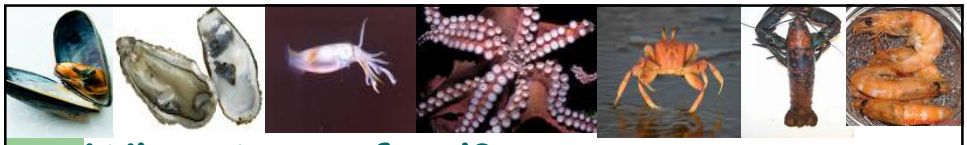

What is seafood?

Seafood includes:

- Fish
  - Freshwater
  - Seawater


- Shellfish
  - Molluscs: mussel, oyster, squid, octopus etc
  - Crustaceans: crab, lobster, shrimp etc
- and also: caviar, turtles, whales, frogs…




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Fish composition

Fish	Moisture	Protein	Fat	Minerals	Edible part %
Carp	72	19	7	1.3	55
Eel	61	13	26	1	70
Perch	80	18	0.8	1.3	38
Salmon	66	20	14	1	64
Pike	80	18	0.9	1.1	55
Herring	63	17	18	1.3	67
Cod	82	17	0.4	1	56
Haddock	81	18	0.1	1.1	57
Catfish	80	16	3	1.1	52
Plaice	81	17	0.8	1.4	56
Sardine	74	19	5	1	59
Mackerel	68	19	12	1.3	62
Tuna	62	22	16	1.1	61

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Seafood composition

Science: Composition: Crustaceans and molluscs

Crustaceans/ Molluscs	Moisture	Protein	Fat	Minerals	Edible part %
Shrimps	78	19	2	1	41
Lobster	80	16	2	2.1	36
Crayfish	83	15	0.5	1.3	23
Oyster	83	9	1.2	2.0	10
Scallop	80	16	0.1	1.4	44
Mussel	83	10	1.3	1.7	18

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Fish composition

Science: Composition: Fish flesh

Composition and nutritional value of fish depends greatly on:

the season of the year,
the degree of maturity,
the food availability,
the temperature, etc.

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Fish muscle structure

In terms of food, **muscle** is the most useful part of the fish.

Fillets (pure muscle cut off the trunk of the fish) can represent 35-40% (whiting , cod) to 65-70% (herring, anchovy) of the weight of the whole fish.

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Fish muscle structure

Fish muscle contains the same protein constituents as the skeletal muscle of mammals, with a few different characteristics.

Myofibrils are similar except that **some are flat** rather than cylindrical.

Fibres are shorter and comparatively thick.

Parallel layers of these fibres (**myomeres**) are attached to sheets of **myocomatta** (the connective tissue of fish).

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Fish muscle structure

In order to allow for intense contraction (required during brief periods of flight or hunting), white muscle, rich in glycolytic enzymes, is predominant.

Brown muscle (5-30% by weight) is particularly well developed in oily fish, such as tuna and salmon. It is relatively rich in lipids and myoglobin.

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Fish muscle structure

Brown muscle is sensitive to cold contraction (after death), and is responsible for deterioration in colour and odour (oxidation of lipids catalysed by the haem-proteins).

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Fish muscle structure

Collagen in fish is present in lower proportion than in mammals,
and it has a lower thermal resistance;
it gelatinises from 35-40°C (instead of 60-65°C for bovine collagen).

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Fish spoilage

In fish the phenomena connected with the appearance and relaxation of corpse rigidity are rapid.
They occur, on average, between 5-22 hours after death (if immediately stored at 0°C).

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Fish spoilage

The pH drops less than in mammals,
from about 7
to 6.5-6.0 for non-oily fish,
to approximately 6.0-5.6 for oily fish.

The lowering of the pH is not sufficient to inhibit or slow down microbial development.

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Fish spoilage

With fish it is difficult to make statements that apply to all fish, because the variables are too many (salt /fresh water, season of the year, inter-species variation etc.)

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Fish spoilage

An additional difficulty is that
- there are no strict criteria and
- little agreement on terms used to describe the condition of the fish, such as 'fresh', 'good', or 'acceptable'.

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Fish spoilage Stability of some fish products

Product	Approximate numbers of days remaining in good condition	
	0°C	16°C
Fresh cod	14	1
Fresh salmon	12	1
Kippers	28	2
Salted herring	1yr	3-4 mo
Dried salted cod	1 yr	4-6 mo

Assuming fish are immediately iced and never allowed to warm up.

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Fish spoilage

In summary, there are several reasons why fish spoil rapidly, and they are

microbiological,

physiological and

chemical in origin.

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Fish spoilage: Microbiological

Healthy live fish are bacteriologically sterile, but many types and numbers of bacteria exist in the surface slime and digestive tracts of living fish.

When the fish is killed these bacteria attack all constituents of the tissues.

As they are mostly psychrophilic bacteria they are well adapted in surviving and growing under common refrigeration conditions.

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Fish spoilage: Physiological

Fish struggle when they are caught, and use up almost all the glycogen in their muscles. There is little glycogen left to be converted to lactic acid after death.

So the preservative effect of lactic acid in slowing bacterial growth is limited.

In contrast, land animals are rested before slaughter to built up glycogen reserves.

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Fish spoilage: Chemical

Fish fat contains phospholipids rich in trimethylamine.

Trimethylamine, split from phospholipids by bacteria and enzymes, has a strong characteristic fishy odour.

Fish coming out of the water has no such odour, so it is evidence of some deterioration.

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Fish spoilage: Chemical

This fishy odour is further strengthened by odorous products of fat degradation.

The fats of fish are highly unsaturated and become easily oxidised, resulting in additional oxidised and rancid off-flavours.

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Fish spoilage: Chemical

Histamine is formed by bacterial decarboxylation of the amino-acid histidine. It is responsible for 'scombroid poisoning', as scombroid fish (mackerel, tuna etc) have high content of histidine.

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Fish spoilage: Chemical

Histamine toxicity has been associated with consumption of fresh, canned, salted, smoked and vacuum packed fish, if they contain high enough levels of the amine, as it cannot be destroyed by processing.

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Evaluating Fish Freshness and Quality

There are some main characteristics we should be looking for when assessing if a fish is fresh:

-eyes that bulge a little and are clear (but some species have cloudy eyes…)

- flesh that is firm and leaves no mark when pressed with a finger (although if it does it might still be good to eat…)

- flesh that is shiny

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Evaluating Fish Freshness and Quality

There are two main sensory evaluation assessments of fish quality and they are very similar:

the Quality Index Method (developed in CSIRO, Australia),

and the EEC descriptive levels (Europe).

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Evaluating Fish Freshness and Quality

The QIM can be more species specific, but scales have to be developed for each species,

The EEC is more general, but as such, sometimes it cannot account for differences between species.

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Evaluating Fish Freshness and Quality

Quality Index Method

QIM

Lower scores indicate better quality.

Quality parameter	Point
General appearance	Surface appearance 0 - 3
	Skin
0 – 1	Slime
0 – 3	Stiffness
0 – 1	
Eyes	Clarity
0 – 2	Shape of pupil
0 – 2 Gills	Colour
0 – 2	Smell
0 – 3	Slime 0 – 2
Flesh colour	Open
surfaces	0 – 2 Blood
In throat cut	0 – 2
Sum of demerit points	

Table 1. Typical QIM scheme (for Cod)

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Evaluating Fish Freshness and Quality

Quality Index Method

QIM

Lower scores indicate better quality.

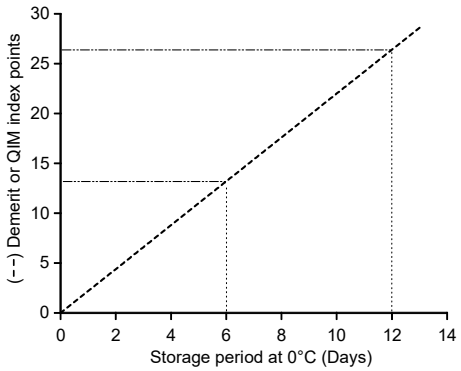

Figure 1. Typical evolution of sensory scores as determined by a QIM scheme like that in Table 1.

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Evaluating Fish Freshness and Quality

EEC descriptive grading

The grades are:
'E' is "exceptional",
'A' is "acceptable",
'B' is "poor",
'C' is "ungraded" or "unsuitable for human consumption"

		E	A	B	Not graded
Skin		bright; shining; iridescent (not redfish) or opalescent; no bleaching	waxy; slight loss of bloom; very slight bleaching	dull; some bleaching	dull; gritty; marked bleaching and shrinkage
Outer slime		transparent; water white	milky	yellowish-grey; some clotting	yellow-brown; very clotted and thick
Eyes		convex; black pupil; translucent cornea	plane; slightly opaque pupil; slightly opalescent cornea	slightly concave grey pupil; opaque cornea	completely sunken; grey pupil; opaque discoloured cornea
Gills		dark red or bright red; mucus translucent	red or pink; mucus slightly opaque	brown/grey and bleached; mucus opaque and thick	brown or bleached; mucus yellowish grey and clotted
Peritoneum (in gutted fish)		glossy; brilliant; difficult to tear from flesh	slightly dull; difficult to tear from flesh	gritty; fairly easy to tear from flesh	gritty; easily torn from flesh
Gill and internal odours	all except flatfish	fresh; seaweedy; shellfishy	no odour; neutral odour; trace musty, mousy, milky, caprylic, garlic or peppery	definite musty, mousy, milky, caprylic, garlic or peppery; bready; malty; beery; lactic; slightly sour	acetic; butyric; fruity; turnipy; amines; sulphide; faecal
	flattish	fresh oil; metallic; fresh-cut grass; earthy; peppery	oily; seaweedy; aromatic; trace musty, mousy or citric	oily; definite musty, mousy or citric; bready; malty beery; slightly rancid; painty	muddy; grassy; fruity; acetic; butyric; rancid; amines; sulphide; faecal

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Fish preservation methods

The main elementary methods of food preservation are applicable in fish:
Sun drying,
smoking,
salting,
and **curing (combination of smoking and salting).**

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Fish preservation methods

More modern techniques have gradually been added, such as **drying in a chamber, canning** and **freezing,** and in general all processes involved are in principal the same as those used for meat and meat products.

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Fish preservation: Drying

Must be carried out **quickly** to avoid decomposition, **but not too quickly** to avoid toughening.

Most commonly is done by forced air drying; a current of dry hot air establishes a difference in temperature and humidity between the flesh of the fish and the air.

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Fish preservation: Drying

Initially drying was carried out –and still is in many countries- in the open air.

However, in this case there is no ventilation allowing the humidity and temperature to be regulated, and as a result we can have excessively long drying times, as well as variable end products.

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Fish preservation: Drying

The rate of drying, the quality of the fish and the cost of the operation depend on various parameters such as:

product temperature,
surface area,
humidity,
temperature,
pressure and velocity of air.

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Fish preservation: Salting

Salting is one of the oldest ways of preserving fish!

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Fish preservation: Salting

Salt preserves fish by removing water from the flesh and using up the remaining water so that spoilage organisms cannot use it for growth.

If enough salt is used, the fish may keep for as long as a year in a cool, dry place.

Salting is often used as an intermediate step, as a way to store fish until you are ready to smoke or pickle them.

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Fish preservation: Salting

Salting –and particular the rate of salt absorption into the flesh - is affected by several factors:

The purity of the salt;
The thickness;
Freshness and fat content of the fish;
The temperature; and
The care and cleanliness used in handling the fish.

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Fish preservation: Smoking

The smoking can be cold, hot or liquid.

Cold smoking takes place at smoke temperatures not higher than 30°C,

In Hot smoking, smoke temperature can be as high as 160°C and in the centre of the fish almost 95°C.

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Fish preservation: Smoking

Liquid smoke, or smoke condensates, is produced by the controlled burning of wood.

That forms a smoke cloud that is extracted by water to dissolve the smoke components.

During the manufacturing, tar and ash are removed from the solution, thus removing almost completely all carcinogens.

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References – Suggested reading

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Thank you very much!

Do you have any questions?