Glossary of Fish Technology Terms

A Selection of Terms Compiled by

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GLOSSARY OF FISH TECHNOLOGY TERMS

[Words highlighted in bold in the text of an entry refer to another entry. Words in parenthesis are alternatives.]

Abnormalities Attributes of the fish that are not found in the great majority of that kind of fish. For example: atypical shapes; overall or patchy **discolorations** of skin or of fillet; diseased conditions; atypical odours or flavours. Generally, the term should be used for peculiarities present in the fish at the time of capture or harvesting, or developing very soon after; peculiarities arising during processing should be considered as **defects**.

Acetic acid Formal chemical name, ethanoic acid. An organic acid of formula CH_3.COOH. It is the main component, 3-6%, other than water, of vinegar. Used in fish technology in preparation of **marinades**.

Acid curing See **Marinating**

Actomyosin A combination of the two main proteins, actin and myosin, present in all muscle tissues.

Additive A chemical added to a food to affect its properties. Objectives of including additives in a product include: increased stability during storage; inhibition of growth of **microorganisms** or production of microbial toxins; prevention or reduction of formation of **off-flavours**; improved sensory properties, particularly colours and appearance, affecting acceptability to the consumer; improved properties related to preparation and processing of food, for example, ability to create stable foams or emulsions, or to stabilise or thicken sauces. **Additives** permitted for use in foods are regulated by food authorities. Typically, there are two lists: additives that may be used without limit in any food; and additives that may be used within maximum limits and/or only in specified foods. Some permitted additives are chemicals naturally present in foods such as ascorbic acid and sodium chloride.

Adenosine triphosphate (**ATP**) See **Nucleotides**, ***K*-value**.

Aerobic plate count (**aerobic colony count**, **aerobic mesophilic colony or plate count**) See **Total viable count**

Affective test A class of experimental procedures used in **sensory assessment** of foods to determine an **assessor**'s personal response the food. Also referred to as a subjective test (ISO 5492). Examples of affective tests are pair comparison tests in which the assessor is asked to express their preference between a pair of products, and **hedonic** tests in which the assessor expresses their degree of liking/disliking or acceptability/unacceptability of a product.

Air blast chiller and air blast chilling See Chilling.

Air blast freezer, **air blast freezing** See **Freezer**, **Freezing.**

Air blast thawing See **Thawing**

Air curtain Continuous stream of air directed downwards or sideways across the doorway of a refrigerated space to reduce the ingress of heat when the door is open.

Air drying See **Drying**

Airlock Small compartment at the entrance to a cold store that prevents direct access and so reduces ingress of heat.

Air speed Rate of movement of air expressed as the distance moved in unit time, as distinct from **air velocity.**

Air velocity The rate of movement of air, in a given direction, expressed as distance travelled in unit time.

Amaranth See **Dye**

Ambient temperature Temperature of the surroundings, usually of the air outside or in a space under study, or of the air in the space surrounding an object or product, or of the surrounding air outside a refrigerated space or enclosure.

Amines A class of chemicals containing nitrogen of which one nitrogen atom at least in the molecule can take on a positive charge. **Ammonia** is the simplest example of an amine. Because of the positively charge nitrogen atom, **amines** are bases and solutions in water have an alkaline reaction. The amines of most relevance in fish technology are the methylamines, **trimethylamine** and **dimethylamine**, and **biogenic amines**.

Amino acid A class of chemicals containing both an amino and an acidic group in the molecule. They exhibit properties of **amines** and **acids** depending on the **pH** of the solution they are in. Amino acids are present in the uncombined form in tissues, and when combined with each other constitute the building blocks of **proteins** and **peptides**. Amino acids and peptides contribute to the flavour of fish flesh. Some have a sweet taste, others a bitter taste. Glutamic acid imparts a meaty flavour in the presence of other amino acids.

Ammonia A chemical with a characteristic pungent, irritating, odour. Has the chemical formula NH_3. It is a gas at normal ambient temperatures and pressures, but can be liquefied by pressure. The change in state on conversion from liquid to gas with a change in pressure is accompanied by a decrease in temperature and makes ammonia a useful refrigerant. Ammonia is not present in living fish, or only in trace amounts, but is formed in muscle tissue by biochemical processes in the tissues soon after death of the animal, and as result of bacterial degradation of nitrogen-containing compounds during **spoilage** of fish. This is particularly evident in elasmobranchs because of the degradation of **urea** prevalent in the muscle tissue of this class of fish.

Anchor worm Parasites of the genus *Lernaeocera* found attached to the gills of fish. As an example, *L. branchialis*, which parasitises cod and haddock, is about 25mm long when stretched out, and about 2mm in diameter. Though they have a simple worm-like shape, these parasites are copepod crustacea, but very degenerated in form as a consequence of their life style.

Angel fillet See **Filleting**

***Anisakis*, Anisakiasis** (**Anisakinosis**) A genus of **nematode** parasites found in the viscera and muscle tissue of many species of fish, but especially in herring. They are capable of infecting humans and causing gastric illness if raw or lightly processed fish, for example cold smoked fish or matje herring, are consumed. The disease caused is anisakiasis. Freezing to below -18ºC followed by frozen storage for 24 hours kills the parasites and renders lightly processed products made from the treated raw material safe for consumption. (Sakanari & McKerrow, 1989).

Annatto (**Anatto**) See **Dye**

Antibiotic ice Ice containing a small amount of antibacterial substance, e.g. a tetracycline, added to extend the shelf life of chilled fish by decreasing the rate of growth of spoilage bacteria. Not generally recommended as an effective treatment or for its potential contribution to the general development of antibiotic resistance, and its use is not permitted in many countries.

Antioxidant A chemical that reduces the rate of oxidation of lipids, a process that ultimately induces **rancid** flavours in the product. Fish muscle naturally contains antioxidants, for example, α-tocopherol (vitamin E), but in low concentrations so they are not effective in preventing rancidity in chill- or frozen-stored fish products. Natural and artificial antioxidants are included among permitted food additives. Antioxidants are often incorporated into fish oils and fish meals, and sometimes added to fish products.

Appearance The attributes of a product assessed by the sight. (ISO 5492). It encompasses properties such as: shape; colour; gloss/dullness; translucency/opacity; surface texture.

Artificial nose See **Electronic nose**

Ascorbic acid, **Vitamin C** A naturally occurring vitamin found in plant products. But, only found in trace amounts in fish muscle tissue. It is an **antioxidant**, and used as permitted food additive for this purpose.

Aseptic canning A **heat sterilisation** process in which the ingredients or potential contents are sterilised outside the container and the container is then filled aseptically (under **sterile** conditions) and seamed. Used for liquid foods and small solids in suspension, but not widely for fish products, e.g. tuna salad, the advantage being shorter, less severe process conditions for more heat sensitive food constituents such as the mayonnaise.

Ash The residue remaining after all the organic matter in a sample has been burned off. Often included in the **proximate composition** of a product.

Ashi See **Surimi**

Assessor See **Sensory panel**

Astaxanthin The red pigment present in the shells of crustacea and the flesh and eggs of salmonids. The astaxanthin in salmonid tissues is obtained by absorption of the pigment from crustacea in the diet of the fish. Astaxanthin, and/or the chemically-related pigment **canthaxanthin** are added to the feeds of farmed salmonids to give the desired red colour. The pigment is also produced by microorganisms such as microalgae that can be cultivated as sources of pigment for fish feeds.

ATP (**Adenosine triphosphate**) See **Nucleotides**, ***K*-value**.

Authenticity See **Electrophoresis**, **Species identification**

Autolysis Breakdown of proteins, lipids and other compounds in fish by the action of enzymes present in the fish especially causing deteriorative changes. The process begins immediately after death and the rate depends on temperature. Also loosely called **self digestion**.

Automatic smoke producer (**Smoke generator**) See **Smoking kiln**

a_w See **Water activity**

Bacillus stearothermophilus See **Thermophilic** and **Canning**

Bacteria Singular bacterium. Single celled microscopic organisms ranging in average size from one to five micrometres, with variable shapes and nutritional needs. Bacteria are prokaryotic, that is, their DNA is in the form of a single strand and not confined within a nucleus, and there are no structures within the cell. Bacteria are widely distributed in nature. They impinge on fish technology in a number of ways. Bacteria are responsible for the spoilage processes occurring in stored fish and fish products, other than in the frozen state. Some species are **pathogens**.

Bacterial counts The numbers of **bacteria** in a sample. The term needs to be qualified by the identifier for the group of bacteria or the species of bacterium being counted. For example, **Total viable count** (**TVC**) is the number of bacteria present in a sample seen as colonies on a non-specific solid bacteriological growth medium under the conditions of test. Selective culturing conditions and culture media are used for individual species or genera of bacteria, for example ***Salmonella***, or for closely related organisms of sanitary significance such as **coliforms**. Bacterial counts are typically specified as number of organisms/g or colony forming units/g (c.f.u./g). See **Total viable count** (**TVC**)

Bacteriological standard A **standard** that specifies maximum **bacterial counts** in a product.

Banding Light stripes on **smoked fish** where the tenterstick or banjo around which the fish is hung, or the mesh on which it has been laid, has prevented contact with **smoke** during the **smoking** process.

Barrel bones See **Filleting**

Batch freezer See **Freezer**

Batter and crumb See **Coating**

Beheading See **Heading**

Belly burst A **defect** in fish in which the belly walls are perforated by the action of gut enzymes dissolving the belly walls. It occurs in **ungutted** fish, particularly when the fish have been feeding heavily and digestive enzymes are very active. Prior to perforation of the belly wall, the belly wall will be seen on opening the belly to be stained and softening.

Belly cavity See **Gutting**

Belly flap See **Gutting**; see **Nape**

Belt freezer See **Freezer**

Benzoic acid An organic acid used as the acid or its sodium or potassium salts as a food additive to preserve the product by inhibiting growth of microorganisms. Generally, it is permitted as a food additive in only a small range of fishery products such as dried fish.

Benzo[*a*]pyrene See **Polycyclic aromatic hydrocarbons** (**PAHs**)

Bilgy fish Fish with a foul smell as a consequence of rapid growth of **anaerobic bacteria** in the flesh in unfrozen fish. The condition occurs, for example, when fish are pressed hard against the side or floor of a container so that air is excluded, and the fish are also warm by being against the sides or floor of an unchilled surface. Also called **stinkers**.

Binary ice See **Icing**

Biogenic amines A type of **amine** formed from **amino acids** in foods by the action of bacteria. Many have physiological effects in humans. They occur in very spoiled fish, especially when spoilage has occurred at high temperatures, above 10ºC. Biogenic amines found in spoiled fish include **histamine**, cadaverine, agmatine, putrescine, spermine, spermidine and tyramine. **Histamine** is of concern because it is associated with **scombrotoxicosis**. (Rawles *et al*., 1996; Lehane and Olley, 2000).

Biscuit cure See **Salting**

Bitter, **Bitterness, Bitter taste** Bitter (adj.) describes one of the basic tastes characterised by solutions of quinine and caffeine. Spoiled fish can have **bitter taste**, perhaps due to the production of bitter **peptides** by degradation of proteins by spoilage bacteria. **Urea**, present in elasmobranchs has a **bitter taste**. **Bitterness** (noun) is the attribute of a substance that has a **bitter taste**.

Bixin (Bixine) See **Dye**

Black spot Blackening of the shell of crustacea, especially shrimp, prawns and lobsters, due to the enzymatic formation of the black pigment melanin. Typically starts at the base of the legs, spreads over the carapace then onto the tail. It is associated with spoilage though discoloration begins before spoilage odours or flavours are noticeable in the tail meat. It can be inhibited by treating the crustacea with sodium sulphite, a generally permitted food additive for crustacea. The process is also called **melanosis**.

Black spot disease See ***Cryptocotyle lingua***

Blackberry odour An unpleasant, sulphide odour (sometimes described as paraffin-like or gunpowder) found occasionally in some species of fish. The odour is due to the presence in the flesh of the fish of **dimethylsulphide** (**DMS**) formed from dimethyl-β-propiothetin in the feed of the fish. The odour usually appears in the spring, and in particular localities, when the fish are feeding on species of pteropods, pelagic gastropod molluscs. Sometimes, termed **weedy**. Cod (*Gadus morhua*), especially

from Spitzbergen and Labrador, tend to develop this condition (**blackberry cod**) when feeding on the pteropod *Spiratella helicina*, and mackerel (*Scomber scombrus*) are known to develop a similar condition (**blackberry mackerel**) when feeding on the pteropod *Spiratella retroversa*.

Blackening (1) A black discoloration found in **canned fish** and shellfish. Caused by defects in the plating or lacquering of the insides of steel cans such that sulphides present in the product can interact with the exposed steel to form black iron sulphide. The blackening might be seen only on the walls of the can, but can extend into the contents. Not the same as **black spot**.
(2) Intense black, localised, discoloration arising from the copepod parasite *Sarcotaces articus*, the **ink bag parasite**, found in blue ling, *Molva dypterigia*. It is a black liquid, and if the sac (ink bag) is cut during filleting the surrounding flesh is stained black. Otherwise the **parasite** can be carefully excised without causing staining.

Blank See **Fish finger**

Blast freezer and **Blast freezing** See **Freezer**

Bleaching, **Bleached** The loss of colour from the skin of fish that is then referred to as **bleached**. It occurs in fish stored in water or seawater, in water **thawing**, or when the fish have been stored in melting ice for a time.

Bleeding Removing the blood from fish soon after capture on the fishing vessel or after harvesting at the fish farm. Recommended for white fleshed fish to avoid **blood spots** and blood **discoloration** in the fillet, which becomes a brown discoloration after freezing and thawing. Also recommended for farmed fish such as salmon, trout and other species, particularly to avoid undesirable dark **discoloration** after **smoking**. White fleshed fish for chilling should be gutted quickly, cleanly and neatly soon after catching, the gut cavity washed, and the fish stowed in ice belly down to allow the gut cavity to drain. White fleshed fish **frozen at sea** should be kept cool before being **gutted**, or **headed and gutted**, left to bleed chilled for up to 30 minutes, and washed thoroughly before being frozen. Fish left **ungutted** for more than a few hours cannot be bled properly because the blood clots in the blood vessels. In handling farmed salmon, it is common practice to enhance **bleeding** by cutting the gill arches during killing, and the fish are kept chilled prior to **gutting**. It is impractical to bleed small pelagic fish caught in large numbers at a time, e.g. herring, mackerel, pilchard and anchovy. See **Gutting** and **Washing**.

Block fillet See **Filleting**

Block ice See **Icing**

Block press See **Laminated block**

Blood curd See **Curd**

Blood pickle See **Salting**

Blood spots Superficial red blood marks on fish, especially noticeable on white fish and salmon **fillets**, which should be readily removed by **washing**. See **Bleeding**.

Blown May refer to a filled **can** after **heat processing** that has swollen ends and is indicative of spoilage of the contents (see **canning**), or it may refer to a fish oil that has been slightly oxidised by blowing air through it.

Blueing A blue **discoloration**, or **blueing**, sometimes occurs during the canning of crab, and the processing of abalone (see **blue spot**).

Blue spot A blue **discoloration** of abalone meat. The colour is probably due to blood, which is blue in colour in abalone, lodging in the meat after death of the animal. Also referred to as **blueing**.

Boneless Strictly means, without bones, but it may mean, nominally without bones, having a specified very low bone content, as in the case of a **laminated block** or **mince block**, or it may refer to some **smoked**

fish products, such as the so-called **boneless kipper**, that has most of the large bones removed and is also called a **boned** kipper. See **Filleting** and **Kipper**.

Boneless fish meat See **Minced fish**

Boneless kipper See **Kipper** and **Kippering**

Bone separator See **Minced fish**

Botulinum cook See **Canning** and **Commercial sterility**

Botulism, botulinum organism, botulinum toxin A type of food poisoning, often fatal, in the form of a paralysing disease of the central nervous system caused by consumption of a powerful neurotoxin produced by the organism ***Clostridium botulinum***, the **botulinum organism**, some types of which are occasionally carried by fish. Death can follow within hours of consumption of the **botulinum toxin**. Outbreaks have arisen from the consumption of uncooked, partially cooked, fermented, canned and smoked fish products. Fish products that are intended to be eaten without further cooking such as some raw products, pickled, fermented, canned, some types of smoked product, and products packed anaerobically (in the absence of oxygen) are those for which most care needs to be taken to avoid the hazard of botulism. In practice, if fish are adequately iced immediately after catching and not kept above 3°C at all stages of processing until eaten, or subjected to an effective **botulinum cook** during **heat sterilisation** in containers where the integrity of the seals and seams remain remain intact, or cooked to destroy the toxin, they will remain safe. **Botulism** is also known as **botulinal** or **botulinum poisoning**. See ***Clostridium botulinum***, **Canning** and **Smoking**.

Bound water The bound water content of a food is the water that is never available for freezing and cannot be frozen out of the food. It is water chemically bound to specific sites such as the carbonyl and amino groups of proteins.

Boxing Normally refers to the practice of packing whole fish (usually gutted) in boxes in ice (usually plastic boxes nowadays to meet hygiene requirements, but traditionally in wooden boxes) in the **fishroom** of a fishing vessel (see **Icing**). Used more broadly it could include the packing of chilled fish or fish products such as fillets in boxes, frequently of the expanded polystyrene type, for overland distribution or for air freight.

Breading, **breaded products** See **Coating**

Brine Solution of a salt in water sometimes used as a secondary refrigerant for **chilling**, **freezing** or **cold storage**; **sodium chloride** or **calcium chloride** is used, but direct contact with food is restricted to the former. A solution of **sodium chloride** (**salt**, preferably **vacuum dried salt**) in water used for **brining** prior to **smoking, drying** or some other form of processing. The amount of sodium chloride in solution is termed the **brine strength**, as measured by the density of the solution in **brineometer** degrees (a type of hydrometer, also called a brine gauge, brinometer, salimeter, salinometer), where 100° is a saturated solution (**saturated brine**) containing 264 g salt per litre of **brine** at 16°C (i.e. 358 g added to one litre of water). Temperature is specified because the amount of salt that can be dissolved depends on temperature. An 80° **brine** is a common working strength for batch **brining** of fish for **smokin**g. The Table below shows the amount of salt needed for a particular **brine strength** and the concentration of salt in the **brine**. Also see **Brining** and **Salt**.

Preparation of sodium chloride brines of different brine strength

Brine strength	Weight of salt added to 1 litre water at 16°C	Weight of salt per litre of brine at 16°C
brineometer degrees °	g	g
10	27	26.4
20	56	52.8
30	86	79.2
40	118	105.6
50	152	132.0
60	188	158.4

70	227	184.8
80	268	211.2
90	311	237.6
100	358	264.0

Brine bath (Brine tank, Brine tub, Brine vat) See **Brining**

Brine freezing See **Freezer**.

Brine immersion freezer See **Freezer**

Brineometer (Brine gauge, Brinometer, Salimeter, Salinometer) **See Brine**

Brine strength See **Brine** and **Brining**

Brining Immersion of fish in **brine** in a **brine bath** (brine tank, brine tub, brine vat) for **salting** before **smoking**, **drying**, **canning** or some other form of processing. **Dye** may be added to the brine for **smoking**. An 80° **brine** is a common working strength for batch brining of fish for **smoking**. In a **continuous briner** (mechanical briner) the fish are conveyed at a speed that can be adjusted to give the required residence time (**brining time**) in the **brine bath** to achieve the desired **salt concentration** and **salt content**. The **brine** is maintained almost at saturation point by passing through a bed of **salt** and continuously recirculated through a sieve to remove debris.
The uptake of salt is a complex process depending on many factors, such as time of immersion in brine, strength and temperature of brine, size, shape, thickness and fat content of the prepared fish, whether the fish is frozen and thawed or unfrozen, presence or not of skin or degree of **scoring** of the skin, ratio of brine to fish, and homogeneity or mixing of the brine. For a particular product, in brine of constant strength and temperature, the uptake of salt is roughly proportional to the square root of the **brining time**. Fish increase in weight due to retention of brine, the more so in brines weaker than 50°; use of **saturated brine** may result in the formation of salt crystals on the drier areas of the smoked product (e.g. head and fins); 70 to 90° brine is recommended for most products. Brines must be kept to strength, changed at least once a day, and scales and other debris removed frequently. Fish in contact with stale brine will be contaminated with microorganisms. See **Brine**.

Brining time **See Brining**

Broad tapeworm See **Diphyllobothriasis**

Brown FK See **Dye**

Browning Refers to a number of **discoloration** conditions found in fish. Brown discoloration, especially of dried or canned fish products, caused by the **Maillard reaction** or **non-enzymic browning reaction**. It is a deteriorative reaction between amino groups of proteins or amino acids and carbonyl groups of sugars (e.g. the reducing sugar ribose in fish which is released during **spoilage**) during storage, particularly of dried and canned foods, that results in flavour changes and loss of some nutritive value as well as **discoloration**. Pre-cooking and decanting of the **cook-out** can help to avoid the problem in canned fish.

Bulk freezing See **Freezing**

Bulking (Bulk stowage) Storing loose whole fish, intermixed with ice, in layers, typically 40 to 50 cm deep, especially in the **fishroom** of a fishing vessel. See **Chilling**, **Icing**, **Boxing**, **Shelfing**.

Burst bellies See **Belly burst**.

Butterfly fillet See **Filleting**

Cake ice See **Icing**

Calcium chloride See **Brine**

Can See **Canning** and **Heat-treated**

Candling The visual examination of fish fillets for nematodes, bones, and other defects by laying the fillet on a translucent plate over a strong light. The translucent plate and light source are usually combined in a **light box**.

Canning A means of obtaining long-term microbiological stability for non-dried foods without the use of refrigeration, by prolonged heating in hermetically sealed containers, such as **cans** or **retortable pouches**, to render the contents of the container **sterile**. This entry does not deal with the detailed stages of the entire **canning** process, e.g. the pre-processing steps such as preparation of the fish, **brining**, **salting**, **smoking**, **marinating**, or the process steps of pre-cooking, exhausting, sealing, seal integrity, retorting, and post-process cooling.

The process depends on a **thermal process lethality**, in terms of exposure time to a specific high temperature, sufficient to effectively eliminate the most dangerous and heat resistant pathogens, particularly ***Clostridium botulinum***. Thermal processes are calibrated in terms of the equivalent time the **thermal centre** of the product, i.e. the point of the product in the container most distant from the heat source or **cold spot,** spends at 121.1°C, and this **thermal process lethality** time is termed the $\boldsymbol{F_0}$ **value**. Low acid foods having a **pH** greater than 4.5, which includes most **canned** fish products, must receive a minimum **thermal process** of F_0 3 (121.1 °C for 3 minutes), known as a **botulinum cook**, or an equivalent **heat sterilisation** process. The heat process F_0 3 is designed to achieve a 12 log cycle reduction in spores of ***Clostridium botulinum***, which means a less than one in 10^{12} chance of survival. This is regarded as an acceptably low level possibility of survival of this dangerous pathogen and is the basis of so-called **commercial sterility**. Canners often use $\boldsymbol{F_0}$ **values** ranging from 6 to 14 for low acid products (see below) to provide an additional safety margin to compensate for inaccuracies in temperature measurement. Canned foods destined for hot countries, or manufactured in hot countries, may require a much higher thermal process, such as F_0 greater than 10. In order to maintain the sterility of the contents of the sealed container, it is essential for product safety that the integrity of the container and its seals are maintained to prevent ingress of microbial contamination after heat treatment. Scrupulous post-process hygiene is paramount particularly during the cooling phase. The main purpose of microbiological testing of heat processed foods is to assess post-processing contamination.

Canned fish products fall into two basic categories with respect to selection of the appropriate thermal process: high acid, less than **pH** 4.5; low acid, greater than 4.5. Fish **marinades** and pickles containing acetic, citric, tartaric or lactic acids, or vinegar such that the **pH** of the product is below 4.5 will not support the growth of spore forming, human pathogens. The organisms that can grow in such acid conditions are destroyed by relatively mild heat treatments, e.g. raising the temperature of the product at its **cold spot** to 90°C and immediate cooling. The low acid category includes most canned fish products, including those canned in tomato sauce, and all require a full **heat sterilisation** process. Typically, the **fatty fish** species such as herring, mackerel, sprat, pilchard, anchovy, salmon and tuna, crustacean shellfish such as shrimp, prawn, krill and crab, lobster and crayfish, molluscan shellfish such as abalone, cockle, mussel, oyster, whelk and winkle, and some other species, are canned. **White fish** do not usually can well. Usually the heat process results in significant changes in colour, texture and flavour of the product compared to the chilled or frozen item. For some products such as crustaceans and tuna, and some mackerel products, the fish or shellfish is pre-cooked before canning. Some problems may occur with the **canning** of fish products, such as excessive formation of **curd** when frozen salmon are canned, or excessive **cook out** or water loss from flesh during cooking. **Discoloration** may occur such as **browning** reactions and **greening** in tuna. **Blackening** may occur, particularly with eels, abalone and albacore tuna, especially when material is held in frozen storage prior to canning, and it is due to the precipitation of iron sulphide during heat processing. Undesirable colour changes in shellfish during canning often involve metal ions. Crustaceans must be canned very soon after death because spoilage is rapid and volatile sulphur compounds, such as hydrogen sulphide produced during spoilage and during heating can react to form metal sulphides. In the presence of iron, tin and copper, dark staining or **blackening** may occur in the can. A blue **discoloration**, or **blueing**, sometimes occurs, especially in crab, and a blue/green **discoloration** can occur in the frill of abalone during the canning, part of a problem with abalone collectively referred to a **blue spot**. **Pink patches** may appear after brining and canning stale abalone. **Struvite** crystals are occasionally found in cans of salmon, tuna, mackerel and crustacea and mistaken for glass by the consumer.

A wide range of containers is available other than the widely used conventional, three-piece, three-seam, open-top, tin-plate can. Both tin-plate and aluminium cans can be drawn from a single plug of metal to have a single seam at the **processors-end** that may have a ring-pull end. The internal surfaces of metal cans are lacquered to prevent internal corrosion and to prevent the fish adhering to the surface of the can. The **lacquers** may be modified, e.g. to confer acid resistance. The external surfaces may also be lacquered where there is risk of external corrosion, for example, at sea or in coastal areas. Glass jars are often used for fish pastes and spreads. The **flexible pouch** or **retortable pouch** enables the degree of **heat processing** required to make the pack **sterile** to be reduced because, compared with a conventional can, it has a higher surface area and is thinner. But, it requires an **over-pressured retorting** regime to prevent rupture of the seals and bursting of the pouch. Typically, the pouch is made from a three layered, bonded laminate of heavy gauge outer plastic polymer, bonded to an intermediate layer of aluminium foil, bonded in turn to an inner plastic polymer layer that can be heat-sealed. The pouch may be protected with an **outer** cardboard carton. The so-called **plastic can** is thermoformed from mutilayered coextruded plastics that can withstand the temperatures of normal **canning** processes, but it also requires an **over-pressured retorting** regime to prevent rupture of the seals. These containers can be lidded with a ring pull metal end seamed onto the plastic body or with a foil laminate heat sealed to the rim. The **thermal conductivity** is lower than a metal can, requiring a longer heat process time to achieve the same **thermal process lethality** than metal cans of the same dimensions. See **Heat-treated** and **Aseptic canning**.

Canthaxanthin An orange red pigment chemically related to **astaxanthin** that can be incorporated in feeds for salmonids to impart a red colour in the flesh. The colour imparted to the flesh is not identical to that produced by **astaxanthin**, but canthaxanthin can be synthesised more easily than can **astaxanthin**. Canthaxanthin is not a permitted food **additive** in some countries.

Carbon dioxide Colourless gas, heavier than air, having a slight smell and used in liquid or in solid form (**dry ice**) as a **refrigerant**. **Dry ice** sublimes at a temperature of -78°C and may be used to maintain a low ambient air temperature in a vehicle or in a container during the transport of chilled or frozen fish.

Carbon dioxide freezer See **Freezer**

Case hardening Undesirable surface hardening of fish due to **drying** too quickly during the initial stages that prevents adequate **drying** of the inner layers of fish. If too high a temperature and/or airspeed is used during drying a relatively impermeable outer layer is formed on the surface of the fish during the initial period of **drying** which effectively halts the **drying** process, and the moist interior of the fish will spoil rapidly. The same undesirable condition can occur during the initial period of **smoking** if the temperature and/or airspeed are too high. See **Drying** and **Smoking**.

Cestodes Tapeworms. Members of the zoological class Cestoda of the phylum **Platyhelminthes**. See **Diphyllobothriasis**.

Chalky fish Fish exhibiting an abnormal chalky white appearance and a watery **texture**. It has been described particularly in halibut in North America, and is associated with fish in which there has been a rapid drop in **pH** after capture.

Champagne system See **CSW**.

Chelating agent Chemicals capable of combining with metal ions to render them ineffective. They are also called **sequestrants**. Examples of chelating agents used in the food industry are **ethylenediaminetetraacetic acid** (**EDTA**), usually as the mixed calcium and sodium salt, and sodium **polyphosphate**. They are used as food additives to complex metal ions, particularly calcium and magnesium that could give rise to **defects**. For example they are added to canned fish to prevent development of **struvite** crystals, and to canned crabmeat to inhibit **blueing** of the meat.

Chilled sea water (**CSW**) Sea water in fixed tanks, especially at sea installed in the hold, chilled by adding **ice**, for quickly and uniformly **chilling**, especially pelagic fish and salmon, by immersion. Portable tank systems have also been developed. In a full tank the proportions of sea water, **ice** and fish should be about 1:1:4 and the water may be circulated by pump or agitated by compressed air (**champagne system**) to maintain a uniform temperature and prevent temperature stratification. The tank is usually

filled one third to one quarter full with equal volumes of sea water and **ice** before the fish are loaded. The sea water can be lowered to about -1°C without freezing the fish to obtain the maximum benefit , and the catch can be cooled more rapidly than by stowage in **ice**. Using the **champagne system**, it is possible to cool herring from 15°C to 0°C within 2 to 3 hours. Some species take up unacceptable amounts of water and salt when kept in sea water, the eyes become cloudy and the gills are bleached as the blood is leached out. Consequently, stowage in **CSW** is usually limited to a maximum of 3 to 4 days.

Chilled water stowage (CWS) The storage of fish in chilled fresh or salt water, the **chilling** being effected by either mechanical refrigeration or the addition of **ice**. (See **Chilled sea water**, **Refrigerated sea water**.)

Chilling Fish and shellfish are among the most perishable of foods. **Spoilage**, which begins immediately after death, can be retarded by reducing the temperature of the fish by either **chilling** or **freezing** as soon as possible after capture. In **chilling**, the aim is to cool the fish quickly to a temperature close to 0°C without **freezing** it. A simple and effective method is to use **ice**. With good **boxing** and **icing** practice, using a fish to **flake ice** ratio no greater than 3:1 and stowage in a **fishroom** operating at 0 to 2°C, fish can be chilled effectively in temperate climates from an initial temperature of 10°C to 0°C within about 8 hours. More rapid cooling can be achieved by using **slush ice** or **binary ice** initially. For example, when mixed with **binary ice** made from 3% brine with an ice fraction of 35% (initial temperature -2.5°C) and allowed to drain so that the fish to ice ratio is about 1:1, fish will cool from 10°C to 0°C in about 1.5 hours. Alternatively, **chilled water stowage** either in tanks of **chilled sea water** (**CSW**) using ice for chilling or in mechanically **refrigerated sea water** (**RSW**) can be used particularly for marine pelagic species, or in chilled or refrigerated freshwater for freshwater species. The temperature of sea water can be lowered to about -1°C without freezing the fish and the catch can be cooled more rapidly in chilled or refrigerated sea water than stowage in ice. Using **CSW** and agitation with compressed air it is possible to cool herring from 15°C to 0°C within 2 to 3 hours. Under optimal conditions, the refrigeration capacity of an **RSW** system should be sufficient to cool the fish to 0°C within a few hours. At temperatures less than -1°C, the fish begin to freeze, and reducing the temperature to the range -1.5°C to -3°C is known as **superchilling** or **partial freezing**. Cooling fish or fish products to a temperature just above and as close to 0°C as possible by forced circulation of cold air over the fish is known as **air blast chilling**. Typically, this is done in the duct or tunnel of an **air blast chiller** in which the stream of cool air is guided over trolleys in a batch chiller, or over a conveyor carrying the product in a continuous chiller.

Chloromyxum thyristes See ***Kudoa thyristes***.

Ciguatera Food poisoning resulting from the consumption of tropical reef-dwelling fish that have become toxic by feeding directly or indirectly on species of toxic dinoflagellates, microscopic marine organisms. The dinoflagellates live on coral reefs attached to algae. Herbivorous fish eat the algae, and the dinoflagellates, and take up the toxin in their bodies. The fish become toxic, but further, are consumed by other species and the toxin is transmitted along the aquatic food chain. The principal, but not only, dinoflagellate incriminated in ciguatera poisoning is *Gambierdiscus toxicus*. Worldwide, it is one of the most frequent sources of food poisoning from marine fish, in the order of some tens of thousand reported cases a year. The two toxins associated with ciguatera are ciguatoxin and maitotoxin. They are very toxic. The level of concern for human consumption is 35 nanog/100g of fish flesh. The toxins are neurotoxins, the symptoms including parathesia (sensation of prickling and tingling in the skin), and weakness may persist for months. Death rates - from respiratory failure - are very variable in incidents from this type of fish poisoning, but are in the range 0.1 to 20%. (Mines *et al.*, 1997).

Classification See **Sorting**. Also refers to the grouping of fish, shellfish, algae, and indeed all other species, scientifically into a formal, hierarchical series of groups. The smallest group regularly used is species, which is given a specific Latin description, e.g. the cod, *Gadus morhua*; the herring, *Clupea harengus*.

Cleaning The process of removing dirt. See **Hygiene**.

Clostridium botulinum Species of pathogenic bacteria found in some fish, mud and marine sediments. These anaerobic spore-forming bacilli grow only in the absence of oxygen and produce one or more of a

series of similar neurotoxins which are readily destroyed by cooking (70°C for 2 minutes), but the spores of the organism are quite heat resistant. There are seven known types of ***Clostridium botulinum***, referred to as types A to G. Types A, B, E and F consistently produce **botulism** in humans, and B, E and F are frequently found in the sea. Some authentic cases of **botulism** have been due to type E, some of which have also been associated with consumption of various seafoods, and so serious attention has been paid to the occurrence of type E in fish and fishery products. Type E and varieties of B and F are found in fish intestines and gills, and in mud from the sea, compared to the other types that are found mostly in soil; they can grow and form toxin at much lower temperatures than the other types; they can grow on fish products at 5°C. See **Canning**, **Smoking** and **Botulism**.

Clupeotoxin A very potent toxin infrequently present in planktivorous species of fish, such as sardines and sardinellas, in tropical waters. The toxin has also been reported in species of horse mackerel, (*Decapterus marosoma*) and trigger fish (*Melichthys vidua*), and crabs. The toxin, a neurotoxin, is derived from the feed of the fish and causes symptoms similar to those of **ciguatera**, but with a higher mortality rate, around 50% of cases. The causative chemical has been identified as palytoxin, a toxin found in various species of marine algae. These marine algae are assumed to be the source of the toxin present in fish.

Coating (Enrobing), **coated products** Fillets and portions may be marketed **naked** without any coating, or incorporated into other products with sauces. However, there are many products in which a coating of batter and breadcrumbs (or a batter alone) is applied, and the traditional British battered and deep-fried fish (fish and chips), Japanese **tempura**, puff-type batter coated fish products, and **batter and crumb** coated (**breaded**) **fish stick** products from the USA, are classic examples of **coated products**. Coating technology is a specialist subject and there are many types of specialist batters, crumb textures and applications available. As an example, the manufacture of products with a **batter and crumb** coating is basically a continuous process known as **breading**. The frozen stick (**blank**), or frozen portion or fillet (frozen or unfrozen), all of which may be pre-treated to improve adhesion of the batter, is first passed through a falling curtain of batter (flour and water paste which may contain ingredients for adding flavour) which coats the whole surface. If necessary, excess batter is blown off with a current of air and the coated product is passed through a bed and curtain of dry crumbs (breadcrumbs) to attain overall coverage. The product may be flash fried to set or fix the coating and then refrozen to –30 °C before or after packaging, for storage and distribution. Many coated products are available with a variety of cooking options, such as baking in a conventional oven, grilling, shallow fat frying, deep fat frying, microwave cooking.

Cod worm Common name given to a parasitic nematode ***Pseudoterranova decipiens***, (formerly named ***Porracaecum decipiens*** and ***Phocanema decipiens***), found in the flesh of cod and, of other species of fish. Its life cycle is similar to that of ***Anisakis*** spp. and seals are commonly the definitive hosts, hence its other common name, '**seal worm**'. See ***Anisakis***, **Nematodes**. (Deardorff, & Overstreet, 1991).

Code of Practice A set of guidelines or instructions for the manufacture of a product or to the carry out an operation. They are elements of a **Quality assurance** programme within a company, or they can be incorporated in, or form part of, official regulations. They can developed and used entirely within a company, or be issued by trade associations or national or international regulatory bodies for more general application. The degree of detail in a **Code of Practice** will differ among these various origins. A processing company will have more than one code. Some will apply to operations common to a plant as a whole. Examples, would be Codes of Hygienic Practice and Codes of Sanitary Practice. Some would apply to general operations such as codes for operation of freezing equipment and for chill and cold stores, some for the manufacture of particular products. These will be very specific about where in a factory the operation will be conducted; who in the company personnel structure will make the product or carry out the operation; the particular machine and equipment to be used; the source of raw material; the nature and preparation of materials to be used in the product; and the manufacture, packaging, and storage of the product. The code will specify the persons responsible for supervising the manufacture of a product, or for an operation, and could incorporate instructions for monitoring quality but, usually, **quality control** would be the subject of separate documents.
Trade bodies might issue agreed **Codes of Practice** to advise members or to act as model codes, or as the basis of quality labelling schemes supported by the trade body. **Codes of Practice** issued by international agencies, for example, **Codex Alimentarius**, or by national agencies will often be part of the regulatory mechanism for ensuring the safety and wholesomeness of products, or to control the

hygienic and sanitary conditions for the manufacture of products. In such cases, the codes could be enforced by force of law.

Codex Alimentarius See **Code of Practice**, **Food hygiene**, **Contaminant**

Cold chain The succession of refrigerated storage and transport links between primary producer and consumer to keep fish chilled or frozen throughout distribution from catching or harvesting to preparation for final consumption.

Cold marinades See Marinating

Cold smoking See **Smoking**, **Smoking kiln**.

Cold spot See **Canning**

Cold storage flavour, **cold store flavour** The unpleasant flavour, with an associated odour, formed in the flesh of lean fish during frozen storage, also called **cold store flavour**. It is variously described as 'turnipy', 'leathery', 'cardboardy' 'wet dogs' (as an odour). It tends to be somewhat persistent in the mouth. Some people, probably about 10-15% of individuals are almost completely insensitive to the odour and flavour. Chemical analysis shows that the causative chemical is hept-*cis*-4-enal formed by the oxidation of phospholipids in the flesh. The flavour, or rather its absence or low intensity, is an important quality attribute of frozen lean fish products, and its development limits their storage life. Packaging to exclude air, or holding in bulk form - whole fish rather than fillets - will reduce the rate of formation of the hept-*cis*-4-enal and, hence, the flavour.

Cold store, **cold storage** A refrigerated and insulated room, suite of rooms, or a large refrigerated and insulated enclosed space, on land or in a ship, for the **cold storage** (**frozen storage**) and preservation of fish and fish products in the frozen state. The generally recommended operating temperature of cold stores for fish and fish products is -30°C, but some species such as tuna are stored at lower temperatures.

Coliforms A group of gram negative, lactose fermenting, bacteria characterised operationally by ability to grow in specified culture media under specified conditions rather by any taxonomic considerations. The number of **coliform** organisms in a sample is typically estimated by the **Most Probable Number** (MPN) method. **Coliforms** include the group of **faecal coliforms** and high numbers of **coliforms** in a sample is an indication that **faecal coliforms**, and perhaps food poisoning organisms of enteric origin might be present. It is more satisfactory for monitoring the hygienic condition of fishery products to test for **faecal coliforms**, but **coliform** count is simpler to conduct, and quicker to produce a result.

Collar bone See **Nape**

Colour, **Colouring**, **Colorant** See **Dye**

Commercial sterility A compromise on the practical impossibility of achieving full sterility in the contents of a hermetically sealed container during commercial **heat processing**, whereby the initial bacterial load is destroyed through sufficient decimal reductions to reduce the possibility of a single organism surviving to an acceptably low level. This level depends on the organism, usually ***Clostridium botulinum***, which the process is designed to destroy. The time required to reduce the number of spores of this organism (or any other micro-organism) by a factor of 10 at a specific reference temperature (121.1°C) is the **decimal reduction time**, or ***D* value**, denoted D_0. The D_0 value for ***Clostridium botulinum*** spores can be taken as 0.25 minutes. To achieve a reduction by a factor of 10^{12}, regarded as an acceptably low level, requires 3 minutes at 121.1°C, and is known as the **process value**, or ***F* value**, designated F_0 so, in this case, $F_0 = 3$, which is known as a **botulinum cook**. See **Canning** and **Heat-treated**.

Comminuted The term is used in a number of ways. It may simply mean minced or fragmented fish flesh. It may refer to flesh mechanically disintegrated to such a degree that the type and previous form of the fish cannot be visually identified, or it may mean similarly disintegrated material from which some

protein has been extracted in a salt solution, as in the preparation of **surimi**. It may refer to fish fillet minced after the removal of bones and skin. See **Minced fish**.

Common salt See **Salt**

Composition The constituents of a product and their amounts in unit mass or volume. See **Proximate composition**.

Condition The nutritional status of a fish; the amount of flesh on the carcass. Sexually mature fish deplete protein in their flesh to build up their gonads in the approach to the spawning season. The spawning season, in spring, follows a period when food for the fish is not abundant and fish further deplete muscle tissue protein as an energy source. As the protein depletes a fish becomes thinner, and its weight decreases. Fish are then in poor **condition**. After spawning, in the late spring and early summer, fish feed well, build up muscle tissue, and are then in good **condition**. Compared with fish in good **condition**, fish in poor **condition** have lower fillet yields, softer-**textured** fillets in both the raw and cooked states, and a tendency to an insipid flavour.

Constant rate drying See **Drying**

Contact drying See **Drying**

Contact freezer See **Freezer**

Contaminant A substance present in fish or fish products coming from sources outside of the fish or product, and not intentionally added in processing, but having implications for the safety or quality of the products. Contaminants might be derived from the natural environment, or from the environment in which the fish has been handled, stored or processed. Mostly, contaminants are chemicals, but they can be physical material such as pieces of metal or complete or parts of insects, in which case they are referred to a 'foreign bodies'. Contamination of fishery products during handling and processing comes from substances such as cleaning and disinfecting agents, or possibly from packaging materials. These affect the quality of the products, and likely render them unfit for consumption. Environmental contaminants might have implications for human health. Examples of particular concern for fishery products are some heavy metals, particularly mercury and cadmium, and persistent, highly chlorinated hydrocarbons such as dioxins and furans, polychlorinated biphenyls (PCBs), chlorinated pesticides such as DDT, dieldrin and mirex. (Moffat & Whittle, 1999). See Codex Alimentarius Commission (1995) for a formal definition of a food contaminant.

Continuous air blast freezer See **Freezer**

Continuous briner (**mechanical briner**) See **Brining**

Continuous freezer See **Freezer**

Control chart The term is sometimes expanded to **Shewart control chart** in recognition of the originator, W. A. Shewart, of this system for quality control. **Control charts** are used to monitor the performance of repetitive operations and indicate when the process should be adjusted to ensure that the outcome of the operation is within specified limits. They are widely used for quality control in the engineering industry, but there is not much scope for their use in fish processing.
There are a few different sorts of **control charts**, but the one likely to be used in fish processing is control by variables. A variable is a measurable quantity such as the dimensions of a seam in canning, or the weight of a portion in a portioning process. The process is sampled at regular intervals and the variable of interest is measured in all units in the sample. The mean value is plotted on a chart against the time of sampling. In this way it can be seen if the process is drifting, that is, if the mean value of the variable is tending to increase or decrease with time. Also plotted on the chart are permitted upper and lower limits, control limits, of the variable. Appropriate action is taken to adjust the process if the trend of sample mean values approaches either of the limits. (Grant & Leavenworth, 1988).

Cook-out See **Canning**

Cooked marinades See **Marinating**.

Copepod parasites Zoologically, copepods are a subclass of the class Crustacea that includes crabs, shrimps and prawns, but copepods are not used for human food, at least not commercially so. Many species are ectoparasites, that is, live on the outside of fish. Fish lice are copepods. Some species take on bizarre, degenerate forms and are not immediately recognisable as copepods. See **Anchor worm**.

Count The number of items in a fixed weight or volume. Frequently used in the marketing of small or moderately-sized fishery products such as shrimps, squid mantles, small pelagic fish. The products are **sorted** and **packaged** by count ranges for marketing. The size grades often have trivial names, like small, large, jumbo, as well as the numeric size ranges. These names are not standardised across commodities, and might not be the same in all markets for a product even though size grades will be harmonised.

Critical freezing zone (Critical zone) See **Freezing**

Critical moisture (water) content See Drying

Cross flow freezer See **Freezer**

Crude protein content See **Protein content**

Crumb (**breadcrumb**) See **Coating**

Crushed ice See **Icing**

Cryoprotectant A substance permitted to be added to products of fish muscle (**additive**) before freezing to prevent reactions in the products during frozen storage that result in impaired functional properties of the muscle proteins. The cryoprotectants most frequently used in fish technology are sugars and polyalcohols, (sometimes abbreviated to polyols), compounds having many hydroxy groups in the molecule. Examples are sucrose and sorbitol. About 8% of cryoprotectants, singly or in combination, are routinely added to **surimi** before making into blocks and freezing. (Park, 1994; Park *et al*, 1997).

Cryptocotyle lingua A digenetic **trematode** parasite infecting many species of fish. It is seen as numerous small black spots in the skin and in the sclera of the eye. The condition is referred to as '**black spot**' **disease**, but it must not be confused with **black spot** in crustacea. The definitive host is a seabird, typically a gull, and intermediate hosts are marine molluscs, such as winkles, and fish. It can be transmitted to animals, including humans, which act as definitive hosts following ingestion of affected fish, but does not appear to cause illness.

CSW See **Chilled sea water**

Curd Refers to the unsightly creamy material covering the surface of fish, especially canned salmon produced from previously frozen fish, and sometimes tuna. It consists of coagulated protein, probably denatured during poor cold storage prior to heat processing. Formation is reduced by pre-cooking, by sealing the cut surfaces of the fish with a **brine** or a tartaric acid dip to prevent the escape of fluid, or by treatment with proteolytic enzymes. See **Canning**. **Curd** also refers to the thick slime which is formed on the exterior of spoiled fish. **Blood curd** refers to the exudate produced during the processing of crabs.

Curing Preserving fish by **smoking**, **salting**, **drying**, **fermenting**, **acid curing**, or any combination of these.

Cut surface Fleshy surface exposed by **heading**, **heading and gutting**, **filleting**, **splitting** or cutting the fish into **steaks**. The cut surface of a **split** fish is referred to as the **face**.

Cutlet See **Filleting**

CWS See **Chilled water storage**

***D* value** See **Commercial sterility**

Deboned fish flesh See **Minced fish**

Decimal reduction time See **Commercial sterility**

Deep freezing See **Freezing**

Deep-chilling See **Superchilling**

Defect, **Defective** Terms with particular meaning in **quality control**, especially in the sampling and testing of products for compliance with specifications. A **defect** is a failure in an item to comply with one or more criteria in a specification. For example, a specification for boneless, skinless fillets might require the weight of the fillets to be within a stated weight range. If a particular item in a sample of a batch of fillets is outside of this range then there is a **defect** in that item. An item can have more than one defect. Using the fillets specification as an example, a fillet might fail on criteria for weight, presence of bones, blood spots and presence of skin. One or more defects in an item will render that item **defective**, that is, not complying with the specification. The decision rules of a **sampling plan** will define the number of **defectives** that may be allowed in a sample for the sampled batch to be declared unacceptable.
The specification, or the associated **sampling plan**, can weight the seriousness of defects. Some defects might be declared critical, and a defect of this sort will render the item **defective** no matter what other defects are present, or not. Presence of pathogenic bacteria, substances that present a risk to health, or non-compliance with regulatory controls, are examples of critical defects. A few bones (number specified), or small amounts of skin (area specified) in the boneless, skinless fillet example could be declared minor **defects**, but more than this would be declared major **defects**. The **specification** or the **sampling plan** would specify the maximum number, if any, of each type of **defect** that may be allowed in a non-**defective** item. See also **Demerit points**.

Defrosting The term is used in a number of contexts. It refers to the removal of frost from a cooler to improve heat transfer, e.g. from a cooling coil. It is used to describe the heating of plates in a **contact freezer** to release frozen produce (hot gas defrost), ease reloading and improve heat transfer. It also refers to the thawing of frozen fish or fish products, see **Thawing**.

Dehydration See **Freezer burn**

Demerit points The essential element of a system for rating the overall quality of an item. The attributes of the product that contribute to its quality are defined. The degree of change in each attribute as quality decreases is rated on a numeric scale starting at a low value, usually 0, for excellent quality of that attribute. The scores on these scales are **demerit points** and the sum of the demerit points allocated to a sample unit grades the quality of the item. The grading might be just a simple pass/fail. The **demerit points** system is analogous to the weighting of defects for seriousness, but allows for more levels of seriousness. The scales need not be of the same length and this allows for a weighting of the seriousness of deviations from excellent quality in the various attributes. **Defects** rated on longer scales will be weighted more in the summation of the demerit points than **defects** rated on shorter **scales** (2).

Denature, **denaturation** (1) One meaning of **denature** in food science is to render a foodstuff unsuitable for consumption because it does not comply with food laws or regulations. An example in fish technology would be where a public health inspector or veterinarian had considered fish unfit for human consumption, or where fish had been withdrawn from the market as a consequence of the EC marketing regulations. The batch of condemned fish might then be sprayed with a dye to indicate it unsuitable or not to be used for human food, and to ensure it is not illegally returned to the market.
(2) In protein chemistry, **denaturation** is the phenomenon of an alteration in the tertiary structure of a protein. Covalent bonds such as disulphide bonds might be broken during denaturation, but there is no breaking the polypeptide chain of the molecule. **Denaturation** almost invariably results in loss of biological activity of the protein, for example, enzymic activity, and in loss of solubility in water or dilute salt solutions. Susceptibility to **denaturation** differs among proteins, and can be brought about by a variety of treatments, chemical and physical. The processes most frequently encountered in fish technology are heating - cooking, pasteurising, retorting - and treatment with acids - marinading. The

main muscle proteins in fish, the **actomyosin** complex, become more difficult to solubilise in dilute salt solution as storage proceeds, and this process is often referred to as '**denaturation**' in descriptions of changes occurring during frozen storage of fish and fishery products. However, it is not clear that **denaturation** of the proteins has occurred; other mechanisms such as cross-linking of actin and myosin molecules, with themselves or other proteins, or with structural elements of the muscle fibre could lead to loss of solubility with unfolding of tertiary structure.

Descaling See **Scales** (3)

Dessication See **Freezer burn**

Deveining Refers to the removal of the **vein** (gut, **hind gut**, intestine, **weed**) from the tail of crustaceans to yield deveined tail meat. The vein runs down the back of the animal between the flesh and the shell to the **vent** at the posterior end.

Dewatering press **Minced fish** recovered from a **bone separator** often contains an undesirable amount of free water, probably from the water used to lubricate the drum of the **bone separator**. This can be removed in a **dewatering press** in which the minced fish is forced by an endless screw along a dewatering drum, with fine perforations, such that the pressure of the screw in the drum may be varied to control the amount of water removed.

DHA (**Docosahexaenoic acid)** See **Polyunsaturated fatty acids**

Dibenzo[*a,h*]anthracene See **Polycyclic aromatic hydrocarbons** (**PAHs**)

Dielectric thawing See **Thawing**

Dimethylamine An **amine** of formula $(CH_3)_2NH$. Formed in the muscle tissue of some species of fish by the action of enzymes on **trimethylamine oxide**.

Dimethylsulphide (**DMS**) A compound with the formula $(CH_3)S$. In common with other sulphides, it has a foul smell. It is formed in spoiling fish by the action of bacteria on sulphur-containing **amino acids** and very likely contributes to the unpleasant smell of spoiled fish. DMS is present in small amounts in the marine environment, derived from the decomposition of a precursor, dimethyl-β-propiothetin, present in some species of marine algae. Some species of planktonic invertebrates graze on planktonic algae containing dimethyl-β-propiothetin, and in turn the invertebrates are eaten by fish. The dimethyl-β-propiothetin is degraded to DMA by the fish which then has the foul smell of the sulphide. This odour, which can render the fish commercially unacceptable if it is strong enough, is variously described as '**blackberry**' or '**weedy**'. (Andreae & Raemdonck, 1983; Herbert *et al*, 1974; Levasseur, 1994).

Dioxins A shortened form of the name for polychlorinated dibenzo-*p*-dioxins, a group of compounds with several, typically 4 to 8, chlorine atoms in the molecule. Typically used as a collective term to include the furans. Small amounts are formed from natural processes such as forest fires, but by far the major contributor of dioxins in the environment is human activities. They are not manufactured for any commercial purpose, but are present as minor impurities in preparations of chlorinated chemicals, and are formed in the combustion of wastes containing chlorinated products. They are very persistent in the environment, and atmospheric transport distributes them around the world so that they are present even in sites remote from industrial activities. They can enter the aqueous environment directly by discharges from terrestrial sources, and concentrations can be relatively high in some bodies of waters affected by industrial discharges, but deposition from the atmosphere is an important additional source so that dioxins are present throughout the aqueous environment. They are not taken up directly from the water by fish, but fish absorb them from contaminated feed.
They are powerful chronic toxins producing a variety of effects. Analysis of dioxins in foods, including fishery products show the presence of several varying in number of chorine atoms in the molecule. The various dioxins are not equally toxic and when expressing summary dioxin concentrations it is usual to weight the concentration of each dioxin for its toxicity relative to the 2,3,7,8-tetrachloro isomer which is considered the most toxic. The WHO has issued toxic equivalency factors for dioxins and summarised dioxin concentrations are often expressed as Toxic Equivalents

(TEQ) concentrations based on these factors. The WHO (World Health Organization, 1998) has established Tolerable Daily Intakes (TDIs) of dioxins at 1-4 TEQ picograms/kg of body weight. Data on dioxin concentrations in fish, and the contribution of fish to dietary intakes of dioxins are summarised in chapters in Moffat & Whittle (1999).

Diphyllobothriasis An intestinal disease caused by **broad tapeworm** parasites of the genus ***Diphyllobothrium***. The definitive hosts of *Diphyllobothrium* are warm-blooded animals including man, and intermediate hosts are firstly aquatic crustacea then fish. Human are infected if they eat raw or lightly processed fish containing the intermediate form of the parasite (Deardorff, & Overstreet, 1991; von Bonsdorff, 1977).

Diphyllobothrium latum See **Diphyllobothriasis**.

Discoloration An abnormal coloration of a product affecting the quality of the product and usually considered a **defect**. See **browning**, **blackening**, **blueing**, **blue spot**, **black spot, greening**, **dun**, **pink**, **blood spots**, and see **canning**.

Discrimination test A type of testing procedure used in the sensory evaluation of foods in which two or more samples are compared and some judgement made on the difference between them. **Difference test** is the preferred term.

Disinfectant, **disinfection** A **disinfectant** is a chemical that kills microorganisms; **disinfection** is the process of using disinfectants to kill microorganisms. Corresponding equivalent terms often used in the context of food premises are **sanitizer** and **sanitation**. Many chemicals act as disinfectants, but only a selected range are suitable for use in food premises. Chlorine in various forms is frequently used as a disinfectant in fish processing plants. It is available as a gas, in a solution as sodium hypochlorite, and in a solid form as calcium hypochlorite. Iodophors are iodine-based disinfectants in solution with surfactants, phosphoric acid, and possibly other compounds. They are often used in hand washes. Quaternary ammonium salts (QUATS) are not as effective as chlorine and iodine, but have advantages of being detergents and of being less corrosive of metal structures. Disinfectants based on phenol or compounds of phenol should not be used in, or in proximity to, fish processing as the they have very strong odours and can **taint** products. (Shapton & Shapton, 1994).

Disodium hydrogen phosphate A chemical of formula Na_2HPO_4, also called disodium hydrogen orthophosphate and sodium phosphate, dibasic. A permitted food **additive** used especially to modulate **pH** as it has an alkaline reaction in water.

Docosahexaenoic acid (DHA) See **Polyunsaturated fatty acids**

Double naped See Gutting.

Double fillet See **Filleting**

Drained weight The weight of the contents of a container of fish after the liquid has been drained off. Also called the fill. Food labelling regulations in most countries, and a requirement in **Codex Alimentarius** standards for labelling of canned fish products, is that the drained weight of the pack be declared. Drained weight is determined by emptying the contents of the can onto a sieve and allowing the liquids to drain off. The remaining material is weighed. The specifications or regulations will usually specify the conditions, for example, size of mesh of the sieve, draining time, of test. Though originally used for canned products, the principle of drained weight can be applied to frozen products, especially to **glazed** frozen products. Here, the drained weight is the weight of product remaining after it has been allowed to thaw and drain under specified conditions.
The following is the procedure for determining drained weight included in the **Codex Alimentarius** Standard for canned salmon, CODEXSTAN 3-1991, Rev. 1-1995:

> '7.4. DETERMINATION OF DRAINED WEIGHT FOR PRODUCTS PACKED WITH EDIBLE OILS OTHER THAN SALMON OIL
>
> The drained weight of all sample units shall be determined by the following procedure:
>
> (i) Maintain the container at a temperature between 20ºC and 30ºC for a minimum of 12 hours prior to examination.

(ii) Open and tilt the container to distribute the contents on a pre-weighed circular sieve which consists of wire mesh with square openings of 2.8 mm x 2.8 mm.
(iii) Incline the sieve at an angle of approximately 17-20°.... and allow the fish to drain for two minutes, measured from the time the product is poured into the sieve.
(iv) Weigh the sieve containing the drained fish.
(v) The weight of drained fish is obtained by subtracting the weight of the sieve from the weight of the sieve and drained product.'

Draining See **Dripping**

Dried salted (**salted and dried; salted dried; dried salt**) See **Salting**

Dried fish See **Drying**

Dried shrimp In many parts of the world, this product is prepared as a condiment, especially for soups, from shrimp regarded as too small for the market. Typically the shrimp are boiled in sea water, and sun-dried or smoked and dried.

Drip, **drip loss** Liquid that exudes from fish flesh, especially when frozen fish is thawed, when it is also called **thaw drip**. The **drip loss** is the amount of liquid that is lost and is usually expressed as a percentage of the original (e.g. frozen) weight. See **Drained weight**.

Dripping (hanging) Leaving brined fish to hang on racks or in the **kiln** while the surplus **brine** drains or drips off before **smoking**. Also called **draining**; see **brining** and **smoking**.

Dry ice See **Carbon dioxide**

Drying Removal of moisture by evaporation from fish, originally as a means of **curing** for preservation. Natural drying in the sun and wind, or drying over wood fires, were the principal traditional means of drying and are still used today in some parts of the world. Drying may take several or more weeks to complete depending on climate and on the size and thickness of fish. Insect infestation is a problem in all climates differing only in species and degree of damage or loss. Removal of moisture reduces the **water activity** ($\mathbf{a_w}$) of the product. The aim for some **dried fish** products is to reduce the water content to about 15%, corresponding to $\mathbf{a_w}$ 0.6 to prevent the growth of bacteria and moulds, such that the product remains edible for several years.
In addition to production of **dried fish**, **drying** is used in combination with **salting** and **smoking**, and in the production of fish meal. It has been an important and integral part of the **smoking** process to give the required texture to the product, and still is for some products. But, in modern smoking processes drying may only play a small role because a succulent product similar to raw fish may be required.
Fish will lose water by drying only if the water vapour pressure of the surrounding air is less than the vapour pressure of the moisture in the fish. The **relative humidity** of the air indicates the degree of saturation of air with water vapour. The fish cools as water is evaporated, termed **evaporative cooling**. Heat is supplied from the surrounding air, or from a heated surface, to balance the heat loss by evaporative cooling and, if necessary, increase the temperature of the fish to increase the rate of evaporation. **Drying** occurs in two stages. During the first stage, whilst the surface of the fish is wet, the **drying rate** depends on the **airspeed**, and the moisture content (**humidity**) and temperature of the surrounding air. If these conditions remain constant, the drying rate remains constant and so this stage is called **constant rate drying**. The second stage begins when most of the moisture on the surface of the fish has evaporated because water can then only evaporate as quickly as it reaches the surface from within by diffusion. When the movement of water through the fish can no longer match the evaporation rate from the surface, the surface becomes dry. This transition point in the drying sequence is termed the **critical moisture** (**water**) **content**. As the amount of water within the fish diminishes, drying becomes progressively slower because the water from deep within the fish takes longer to diffuse to the surface, and so this stage is known as **falling rate drying**.
Three types of process can be used to dry fish to provide faster drying rates than natural drying. However, too rapid drying must be avoided to prevent occurrence of **case hardening**. In **air drying** or **contact drying**, heat is transferred to the fish from heated air or from a heated surface and increased air movement above the fish is used to carry the moisture away. Suitable conditions for **air drying** in the

dryer are: air speed over the fish, 60 to 90 m/minute; air temperature about 24°C, but within the range 15 to 27°C; **relative humidity** of the air in the dryer, 50 to 55%. In **vacuum drying**, the evaporation rate of water from the surface of the fish is increased as the atmospheric pressure is reduced. Heat is supplied to evaporate the water by conduction by contact with a heated surface, or by radiation, and the water vapour is removed by means of a vacuum pump. In **freeze drying**, highly efficient vacuum pumps attain very low pressures in a sealed chamber that contains the fish in contact with refrigerated plates to freeze the fish. Ice sublimes to water vapour at pressures below 0.64 kPa and the water vapour is removed by the vacuum pump. See **Stockfish**, **Salting**, **Smoking**, and **Freezer burn**.

Drying rate See **Drying**

Dry salting Embedding whole fish, gutted fish, gibbed fish, split fish, fillets or sides in solid salt for salt curing, or as an alternative to **brining** before **smoking**. See **Salting**.

Dun The brownish discoloration of dried salted fish caused by caused by moulds, especially *Sporendonema* spp.

Dye (Colour, Colouring, Colorant) Permitted colours satisfying the criteria for purity for food use, that can be used only as specified in the food **additives** legislation of different countries. In the case of some **smoked fish**, the permitted colour, mainly yellow, orange or brown, is usually applied as a component of the **brine** used for **brining** to intensify the colour obtained during **smoking**. For example, in European Community legislation, **annatto** (**anatto**) is a yellow vegetable dye sometimes used to colour fish before smoking, such that the maximum level in the smoked fish is 10 mg/kg; it is identified as E 160b, and is also known as **bixin**, **bixine**, and **norbixin**. **Brown FK** is sometimes used in the brine to colour herring for **kippering**, such that the maximum level in the kipper is 20 mg/kg; FK is simply an abbreviation of 'for kippers'. It is identified as E 154 and also known as kipper dye. **Amaranth**, a red colour identified as E 123, is permitted in fish roe up to 30 mg/kg. Other specific **colours** are also permitted in EC legislation for inclusion in other fish products such as pastes, pre-cooked crustacean meats, salmon substitutes, surimi, fish roe, soups and smoked fish.

Earthy/muddy odours/flavours **Taints** sometimes present in freshwater and brackish water fish and crustacean shellfish in both natural and farmed environments. The causative chemicals have been shown to be geosmin and 2-methylisoborneol released by microorganisms in the water. The chemicals are taken up by the fish through their gills to induce the **taint** in the flesh. The two chemicals have extremely low detection thresholds, in the order of 1 nanog/l. The character of the odours of the chemicals are similar and give rise to the same descriptions of earthy or muddy, though experienced assessors can differentiate between them. The presence and intensity of the **taint** varies seasonally and is associated with blooms of cyanobacteria in the phytoplankton in the warmer months. In aquaculture, pond conditions affect both the intensity and the composition of the phytoplankton flora; nutrient levels influence the growth of the phytoplankton, and factors like hardness and **pH** affect the composition. Geosmin and 2-methylisoborneol are produced by different species of organisms. For example *Anabaena* species produce geosmin, *Oscillatoria* species 2-methylisoborneol, and generally a pond will support one genus or the other. The responsible cyanobacteria do not grow in seawater - they are inhibited above about 2% salt content - and marine fish are not susceptible to the **taint**. The **taint** is taken up very rapidly when the chemicals are formed, but takes several days to depurate when affected fish are transferred to uncontaminated water.

EC grading A system of **grading** batches of fish, including crustacean shellfish and cephalopods, at port markets for freshness and size. The grades are specified in European Community Council Regulation No. 2406/96 and apply to almost all of the fish landed in the European Community. The fish must first be **sorted** into batches of similar size and freshness, and grades are allocated to the batches by inspectors. Four freshness grades of vertebrate fish are defined - Extra, A, B, C, and unfit; three, Extra, A, and B for Norway lobsters and cephalopods; and two, Extra and A for shrimps. Only fish in grades Extra, A, B, and C may be marketed for human consumption. Two to five size grades are defined depending on the species of fish. Size grades for vertebrate fish and for Norway lobsters are defined in the Regulation by weight, and shrimp and crabs by width of shell. The freshness grades are determined by sensory assessment of the raw fish, predominantly by appearance, and the Regulation gives tables for the grading in five broad groups of species - whitefish, bluefish, elasmobranchs, cephalopods, and

crustacea. The grading scheme is intended to help the sale and marketing of fish at the port markets, and it is a component of the price support mechanism operated by Producer's Organisations.

Eicosapentaenoic acid (**EPA**) See **Polyunsaturated fatty acids**.

Elasticity A textural property. The ability of a material to return to its original shape when a deforming force is removed. Synonyms used in food quality are rubberiness and springiness. When very fresh fish is pressed with a finger, the finger indentation restores rapidly when the pressure is removed, that is, it is elastic; in a stale fish the indentation remains, that is, it is plastic, capable of flowing under pressure.

Electrical resistance thawing See **Thawing**

Electronic nose A device for assessing the quality of a product by analysing the constituents of the vapours in the headspace above a sample of the product. The instrument consists of an array of detectors of different sensitivities to chemicals likely to be in the headspace coupled to a data collection and processing system. There are analogies to odour detection and recognition - the sensor array mimics the olfactory epithelium, and the data recognition and processing system the brain. Hence the term. A variety of types of sensors are available, and usually 4-30 sensors are assembled in the detector unit. The sensors have different outputs when exposed to a mix of gases and the pattern of responses is analysed by the data processing system. For use, the instrument has to be trained with known mixes of gases or, more practically, examples of a particular food commodity of different, and defined, qualities. An example from fish technology would be iced fish of a particular species differing in freshness; the freshnesses must be known or be measured by a reference method. The patterns of responses of the members of the training set are related to the corresponding quality parameter by multivariate statistical methods, for example, discriminant analysis, or by artificial intelligence, neural network, procedures. The measured response pattern from a test sample is referred to the calibration parameters and the most likely value of the quality parameter is estimated. The use of **artificial noses** for measurement of the quality of fish products has been studied in research laboratories, but it is too soon to evaluate the applicability of **artificial noses** for quality control in industry (Mielle, 1996).

Electrophoresis The motion of electrically charged molecules or particles in a fluid medium under the influence of an electric field. Particles with a positive charge move to the cathode, those with a negative charge to the anode, and the larger the charge on the particle, the faster the motion. Proteins and deoxyribonucleic acid (DNA) molecules are charged, and **electrophoresis** forms the basis of procedures for separating these compounds. For various reasons, the separation is usually effected in weak gels of agar or polyacrylamide rather than in free solution. The gels are cast in tubes to form a rod, or as slabs. **Electrophoresis** is used to identify the species of fish of unknown provenance or which might be mislabelled, accidentally or fraudulently. An aqueous extract of the sample is prepared and applied to one end of the rod or slab of gel. An electric potential is applied to the ends of the gel preparation in a suitable apparatus, and the proteins separate as bands in the gel under the applied potential. After a suitable time the gel is stained to show up the protein bands. A pattern of bands is peculiar to a species and allows identification of the sample. (Mackie, 1997).

Electrostatic smoking See **Smoking**.

ELISA An acronym for Enzyme Linked Immunosorbant Assay. The basis of a test which is widely used in food microbiology to identify, and quantify the numbers of, microorganisms. The test is based on the reaction of an antigen in the microorganism with an antibody specific to that antigen in the presence of an enzyme which is usually coupled with the antibody. The enzyme is involved in a reaction which has a coloured end-product, and the development of the colour, and its intensity, indicates the presence of the organism and its numbers. A wide variety of commercially produced kits are available to test for microorganisms and toxins in fish products.

End-product testing A term used in quality control applying to the testing of a product at the end of the production process (**end-product**). It is to be compared to continuous testing where the product is tested at various stages in the process, though **end-product testing** can be applied as well as continuous testing.

Enrobing See **Coating**

EPA (**eicosapentaenoic acid**) See **Polyunsaturated fatty acids**

Escherichia coli The most common aerobic organism in the gut of warm blooded animals and man, and therefore found in sewage polluted waters, but also found in unpolluted warm tropical waters. Most strains are harmless but, within the species, there are at least 4 types of strains pathogenic to man. Generally, the presence of *E.coli* in foods is undesirable because this indicates poor hygiene, but shellfish, particularly bivalve molluscs, from sewage contaminated inshore waters will carry high loads of *E. coli*. Many countries prohibit the sale of live bivalve molluscs and other shellfish unless contamination with *E.coli* or **faecal coliforms** is below a specified threshold value. For example, in the European Community live bivalve molluscs for immediate human consumption must contain less than 300 **faecal coliforms** or less than 230 *E.coli* per 100g flesh and intravalvular fluid.

Ethoxyquin The trivial name for the chemical 6-ethoxy-1,2-dihydro-2,2,4-trimethylquinoline. It is used as an **antioxidant** in fish meal, especially meal from fatty fish, and in animal feeds. Generally not approved for use in foods for humans other than in minor ingredients such as spices.

Ethylene diamine tetra-acetic acid A generally permitted food **additive** used especially in the fish canning industry. See **chelating agents**.

Evaporative cooling See **Drying**

Eviscerating See **Gutting**

***F* value** See **Canning** and **Commercial sterility**

Face See **Cut surface**

Factory ship A vessel, that may also be a fishing vessel, equipped to process fish on board in one or more ways, such as canning, freezing, production of frozen fillet blocks, production of fish meal. See **Frozen at sea**.

Faecal coliforms A subset of the **coliform** group characterised by ability to grow in selective culture media at a temperature of 44.5ºC. The number of **faecal coliform** organisms in a sample is typically estimated by the **Most Probable Number** (MPN) method. The presence of **faecal coliforms** in a sample of a food is almost certainly evidence of contamination of the food with organisms of enteric origin. The organism ***Escherichia coli*** makes up most of the **faecal coliforms**, but further tests are required to identify the organism.

Falling rate drying See **Drying**

Fat A component of foods. **Fats** are mixtures of components and are operationally defined as the fraction of the food that is soluble in organic solvents such as ether, hexane, chloroform. The amount of **fat** extracted depends on the solvent used and the extraction conditions used, so the reported **fat content** of a sample can vary slightly with the analytical procedure. The fats extracted from fish are liquid at typical room temperatures and are often referred to as **oils**. Fats are also called **lipids**. The main components of depot fats are triglycerides (triacylgycerols), **fatty acid** esters of glycerol. See **fatty fish**.

Fatty acids Chemically, a class of aliphatic compounds containing a carboxyl group. The fatty acids in foods or derived from fats are monocarboxylic acids of the general formula R•COOH where R is an unbranched hydrocarbon chain. The higher carbon number members of the series with a carbon chain length above 8, (though this is not a hard dividing line between higher and lower), are odourless and flavourless when pure. The lower members are flavoursome and are produced during microbiological spoilage of fish imparting sour and cheesy flavours to spoiled fish, especially **fatty fish**. The higher members are components of fats, hence the origin of the term. A wide range of fatty acids have been identified in fats, but the most frequently present have even numbered carbon atoms in the molecule in the range 10 to 28. The carbon chain can be saturated or contain double bonds (unsaturated). The **polyunsaturated fatty acids** are important components of fish oils.

Fatty fish Fish in which the main reserves of fat are in the body tissues, e.g. herring (*Clupea harengus*). **Fatty fish** with a seasonally low fat content may be referred to as **lean fish** or **spent fish**. See **White fish**.

Feedy fish Fish that have been feeding heavily such that the gut is full of food when caught. Consequently, the gut enzymes are very active and such fish are liable to **belly burst** unless they are gutted. The term is used especially with pelagic fish when they are feeding on plankton blooms.

Fermenting, Fermented fish Refers usually to the enzymic liquefaction of fish, small crustaceans and squid to produce edible sauces or soft pastes particularly in Asian countries. In southeast Asia, these sauces are be made from salted fish in which bacterial action is inhibited by the salt but autolytic enzymic digestion takes place. Some products are mixed fermentations of fish and/or shellfish with vegetables or cereals by the use of lactic acid bacteria, moulds or yeasts.

Fillet block See **Laminated block**

Filleting and Fillet Cutting by hand or by machine, roughly parallel with the backbone, a strip or slice of largely **boneless** flesh from along the length of a fish to produce from one side of the fish a **fillet** or, more precisely especially from **roundfish**, a **single fillet**; it is also called a **side** especially with reference to salmon. In tuna, the four strips of light muscle cut from the fish, two from each side, are called **loins**. Filleting machines are available for many species but hand filleting is still used widely, and may be preferred even when machines are available because the yield of fillet is better by hand. The amount of **belly flap** and **lug** left on the **fillet** depends on the way in which the fish was **gutted** or **headed and gutted** and the way in which the fillet is subsequently trimmed. The rib bones remaining at the anterior (neck) end of a fillet from **round white fish** are known as the **pin bones**. The number of bones remaining depends on subsequent trimming of the fillet by **V-cutting** or **J-cutting** to give a **boneless** fillet. The rib or chest bones, some of which are severed by filleting and remain in the edible part of a herring or **kipper** fillet, for example, are sometimes called the **barrel bones**. A **block fillet** is flesh cut from both sides of the fish so that the pieces from each side of the fish remain joined along the back. It may be specified as having all bones removed except the pin bones. This cut or fillet is also known as an **angel fillet**, **butterfly fillet**, **cutlet**, **double fillet** or, when smoked, a **golden cutlet**. See also **Gutting** and **Splitting**.

Firebed See **Smoking kiln**

Firebox (**Smoke producer**) See **Smoking kiln**

Firmness The property of not yielding easily to pressure. It can be assessed by the fingers, for example, when assessing the quality of raw fish, or in the mouth when assessing cooked fish. A component of **texture**.

Fish content The amount of the fish component of a composite dish or product containing fish. Usually expressed as a percentage. **Fish content** is usually referred back to the amount of raw fish used in the product, and is not the same as fill applied to **canned** products. Regulations might specify the minimum **fish contents** of some products such as fish cakes and fish spreads, and custom or **Codes of Practice** might require minimum fish contents in products such as **coated** and **glazed** products. It is not easy to measure accurately the fish content of finished products and **quality control** is best effected by control of the amounts of ingredients used in preparation of a product. The fish content of **coated products** can be measured by carefully scraping off the coating under prescribed conditions. Fish content of **glazed** products can be determined as the **glazed weight**. Fish content can be estimated from the **nitrogen content** of the blended product by multiplying the **nitrogen content** by a factor representing the average nitrogen content of the fish component of the mix. This procedure has some uncertainties associated with it. Components of the mix other than fish are likely to contain nitrogen and this non-fish nitrogen has to be allowed for by determining the amounts of these other components and correcting for their nitrogen contents. Another factor is that the nitrogen content of a particular type of fish varies intrinsically, or perhaps by some pre-processing operation before the fish is incorporated in the product, so that the **fish content** of a sample can be over- or underestimated when the average nitrogen content is used. This can have important consequences if regulations relating to minimum fish contents of a product are in force and end-products are being monitored by regulatory agencies. See **Nitrogen factor**, **Protein content**.

Fish finger (Fish stick) and Fish portion Rectilinear or cuboidal portion (**blank**), typically 18 g in weight with a length at least three times the breadth, usually cut automatically after **tempering** from a regular block of frozen fish flesh, often nominally 7.4 kg in size and usually from white fish. The block may be composed entirely of skinless, **boneless** fillets (a **laminated block**, **fillet block**). The block may be jumble-packed or orientated and layered, and composed of skinless, boneless fillets plus the recovered fish flesh from the **V-cuts** (a **laminated block**), or composed entirely of **recovered fish flesh** or **minced fish** (a **mince block**). The **blank** is often coated with a **batter and crumb** coating, flash fried, packed refrozen, distributed and sold frozen. The coated fish finger may contain about 50% fish by weight, but this will vary according to the product, and must of course conform with any relevant food labelling or other legislation. The **fish portion** is a larger size, perhaps up to 100 g, also cut from the larger, 7.4 kg, regular block, and may be cuboidal, trapezoidal, or some other shape. It may be coated in **batter and crumb**, batter only, covered in a suitable sauce, or form the basis of a more complex frozen recipe dish, or sold **naked** without any form of **coating**. See **Laminated block**.

Fish gel See **Surimi**

Fish mince See **Minced Fish**

Fish portion See **Fish finger**

Fishroom An enclosed space, usually partly or wholly insulated and sometimes refrigerated, in a fishing vessel or **factory ship** for chilled storage of the catch. See, **Chilling**, **Icing**, **Boxing**, **Bulking**, **Shelfing**.

Fish stick See **Fish finger**

Fish tapeworm See **Diphyllobothriasis**.

Fish Tester The name given to an electronic instrument manufactured by Intelectron GmbH, Hamburg, for determining the freshness of fish. The measuring head consisted of a pair of electrodes attached to arms of a caliper device, and the electrodes were applied to the fish just behind the head. Properties of the current passing between the electrodes changed systematically as the fish aged and were measured as an index of freshness.

Flake ice See **Icing**

Flap See **Heading and gutting**

Flash freezing See **Freezing**

Flatfish See **Roundfish**

Flat sour See **Thermophilic**

Flatworms See **Trematodes**.

Flavour/odour The sensory experience perceived by assessing foods in the mouth, other than the experience of **texture**. It is a combination of **odour** assessed in the nose from vapours passing through the back of the mouth to the nose and of **taste** assessed on the tongue. (ISO 5492).

Flavour profile An experimental procedure used in the sensory evaluation of foods. The assessor describes the flavour of a product typically using descriptors from a prepared list of terms, though some systems - free choice flavour profiling - allow each assessor in a panel to use their own descriptors. The assessor also rates the perceived intensity of each flavour 'note' identified. The results are combined over members of a panel of assessors and the resulting assemblage of terms and intensities forms the **flavour profile**. Also called Quantitative Descriptive Analysis though this can include sensory properties other than **flavour**, for example **odour** and **texture** (Lawless & Heymann, 1998; Meilgaard *et al*., 1999).

Flexible pouch See **Canning**

Flow ice See **Icing**

Fluidised bed freezer See **Freezer**
Flukes See **Trematodes**.

Food Hygiene, **Hygienic** The science and practice of ensuring food is safe to eat, that is, will not cause harm to the consumer of the food. **Hygienic** practices for fish processing and handling cover a wide range of activities, but the main elements are:

- control of the origins of raw materials to ensure they do not contain noxious substances;
- control over the construction, equipping, running and maintenance of premises where fish is handled processed and stored to prevent contamination of the products with noxious agents;
- ensuring that persons coming in contact with the product adopt good hygienic practices;
- ensuring that fish, inputs to the process, and finished products are packaged and stored under conditions that preclude contamination.

See **Hazard Analysis Critical Control Point (HACCP)**, **Sanitation**. (Codex Alimentarius, 1997; EASTFISH/SIPPO, 2000; Hobbs & Roberts,1993; FAO, 1994; Shapton & Shapton, 1994).

Food poisoning Illness as consequence of consuming food containing a noxious agent. Food poisoning is frequently associated with gastroenteritis but, in the wider context of food safety, illnesses other than those involving the digestive tract should be included. A wide variety of agents cause food poisoning, but they can be considered in two broad classes: biological, and chemical. Biological agents are those than can grow and replicate in the body, and it is this growth that results in illness. Illnesses resulting from growth of organisms in the body are infections. Examples in fishery products are bacteria, viruses, and parasites. A general term for a chemical that can cause harm is poison, but this term applies to any injurious chemical whatever the route of exposure. Poisons that are generated by biological processes are referred to as **toxins**. The illness caused by a toxin is a toxicosis. Examples of poisons responsible for food poisoning that are not toxins are heavy metals such as cadmium and mercury. These can be present in the natural environnent from both natural processes and from industrial source Others are highly chlorinated manufactured compounds like some pesticides, PCBs and **dioxins**. Examples of **toxins** are chemicals produced by bacterial growth in the food before consumption such as staphylococcal and **botulinum toxins**, and substances formed by plants (algal toxins) or animals which are not human food, but are food of fish, including shellfish, and transmitted to humans who eat the contaminated products. Microbiological and viral agents in fish typically cause acute illnesses, that is, illnesses with moderately rapid onsets, i.e., hours, after consumption of the contaminated food. Parasites cause chronic diseases, illnesses with a slow onset that persist over years. **Toxins** poisoning typically results in acute illnesses with rapid onsets, whereas non-biological poisons can cause both acute and chronic illnesses. (Ahmed, 1991; Howgate, 1998; Hobbs & Roberts, 1993; US Department of Health and Human Services, 1991; Moffat & Whittle, 1999).

Formic acid An organic acid, formula H.COOH. The simplest of the **fatty acids**. Used in fish technology for the preparation of **silage**.

Freezant A **refrigerant** suitable for contact with food and used to freeze fish especially by spraying or by immersion.

Freeze drying Dehydrating fish by first freezing it and then subliming the ice that is formed under reduced pressure. In **freeze drying** highly efficient vacuum pumps attain very low pressures in a sealed chamber that contains the fish in contact with refrigerated plates to freeze the fish. Ice sublimes to water vapour at pressures below 0.64 kPa and the water vapour is removed by the vacuum pump.

Freezer Correctly refers to equipment for freezing fish either in a batch or continuously. Loose use has also established a meaning for the term as equipment for the cold or frozen storage of frozen fish, e.g. home freezer, walk-in freezer, upright freezer, chest freezer, and for derived terms such as **freezer burn**. A **batch freezer** is loaded completely at the start of freezing and emptied when **freezing** is completed; the product remains stationary. In a **continuous freezer** the fish is moved continuously on a conveyor belt (**belt freezer**), which may be an open mesh belt, a link belt or a flat continuous stainless steel

sheet, or moved on trucks (**truck freezer**). But, confusingly, **truck freezer** also refers to a batch **air blast freezer** in which the fish remain stationary on trucks.
There is in use a wide variety of methods of **freezing** and types of freezing equipment. In an **air blast freezer**, fish is frozen in a stream of high velocity cold air either in a batch or continuously, typically in a duct or tunnel in which a stream of cold air is guided over the product on shelves (batch) or on a conveyor (**continuous air blast freezer**); also called **blast freezer**, **freezing tunnel**, **tunnel freezer**. Mesh or slatted conveyor belts may mark the product with indentations and are difficult to keep clean, whereas a solid stainless steel belt (as in a **Torry freezer**) does not mark the fish and is easy to keep clean. In good practice, air blast freezing can be achieved by using air at -35°C (or as low as -60°C in some designs) in contact with the product and moving over the product at an **air speed** or air velocity of 3 to 25 m/s. The **air speeds** at the upper end of the range are used on **factory ships**. The speed selected depends on the size and shape of the product, whether the process is batch or continuous, the stability of the product on the carrier, the final temperature of the product, and the economics. Prolonged higher air speeds can cause severe **dehydration** on the surface of the product, resulting in **freezer burn**. Generally, the aim is to quickly reduce the temperature of the warmest part of the product to -20°C at the **thermal centre** (which may not be the geometric centre, depending on product shape), so that the average temperature of the product leaving the freezer is at or below the desired temperature of -30°C. A **continuous air blast freezer** in which the cold air flows at right angles to the direction of movement of the fish is termed a **crossflow freezer**. In a **series flow freezer**, the air flows in the opposite direction to the product. A **spiral freezer** is a belt, air blast freezer in the form of a spiral to reduce floor space. The **multi-pass freezer** was also designed to reduce the floor space required. The product is transferred in the freezer from one belt to another, travelling backwards and forwards along the length of the freezer, usually in three passes, before discharge. In a **fluidised bed freezer**, freezing is done in a trough with a perforated base through which an upward flow of cold air entrains the produce, usually of small unit size such as shrimp, and causes it to behave like a liquid. In a **contact freezer** or **plate freezer** the fish is frozen by direct contact with a refrigerated surface, typically between two hollow metal plates cooled by a refrigerant, such that the distance between the plates can be varied up to 100 mm or more. One type in which fish, especially in flat packs such as **laminated blocks**, is frozen between two or more hollow, horizontal, parallel plates through which refrigerant passes is known as a **horizontal plate freezer**. In a **vertical plate freezer**, the refrigerated, parallel plates are vertical, and it is used mainly at sea or onshore for freezing large 25 or 50 kg blocks of whole, gutted, or headed and gutted fish. The **immersion freezer** or **spray freezer** is mostly used for **IQF** products of small size frozen within minutes. The fish product to be frozen is in direct contact with the refrigerated liquid (**freezant**). One type is b**rine freezing** by immersing fish such as tuna in a tank of recirculating cold sodium chloride brine at about -15°C in a b**rine immersion freezer** that may take about 3 days to freeze a large tuna completely. In a **liquid nitrogen freezer** (**nitrogen freezer**), freezing is by spraying liquid nitrogen at -196°C onto, or into the air around, a fish product, or by a combination of these. The product is usually moved continuously through the freezer on a conveyor, and the system is designed to avoid stress cracking of the product as a result of cooling too rapidly. Similarly, in a **carbon dioxide freezer** there is continuous rapid freezing by spraying liquid carbon dioxide onto, or into the air around, a fish product, or by a combination of these, or by placing the product on a bed of solid carbon dioxide on a conveyor belt under a spray of liquid carbon dioxide. A temperature of about -75°C can be achieved. Freezing in both these systems is very rapid within minutes and **drip** losses on thawing are less than 1%.

Freezer burn Damage to frozen fish caused either by excessive **drying** during cold (frozen) storage as a result of undesirable migration of water from the frozen fish, or by excessive **drying** during **air blast freezing** at high air speeds for excessive lengths of time. It is usually indicated by matt white patches (dull, without gloss) on the surface of the frozen fish and a dull, non-glossy surface on the thawed product. Also termed **dehydration**, **dessication** and **drying**.

Freezer capacity The weight of a specified product that a freezer can hold and also called the **freezer load**, whereas the **freezer output** is the weight of a specified product that can be frozen in unit time to the required storage temperature under specified operating conditions.

Freezer load See **Freezer capacity**

Freezer output See **Freezer capacity**

Freezing Extracting heat and reducing the temperature of fish in a **freezer** to a point at which almost all of the water in it has solidified. About 321 kJ of heat have to be removed from 1 kg of fillets from a lean fish such as cod to freeze them from 5°C to -30°C. The temperature of the fish falls rapidly to the initial **freezing point** at about -1°C when the phase change begins and ice crystals are first formed, because salts and other substances that are present naturally result in depression of the freezing point from 0°C. Thus, fish does not have a precise **freezing point** (**initial freezing temperature**). The temperature then falls slowly between -1°C and -5°C, whilst a large amount of heat is extracted to freeze the bulk of the water in the flesh to ice; heat removed at this stage is termed **latent heat**, and this temperature range is known as the **critical freezing zone** (**freezing zone**), or the **thermal arrest**. After about 75% of the water in the fish is frozen and the critical zone is passed, the temperature again falls rapidly as the frozen fish is cooled further. The recommended temperature to which fish should be reduced during freezing is -30°C, at which temperature the fish should be stored (tuna is usually stored below this temperature to reduce the rate of some undesirable quality changes in pigmentation).
In practice, with a freezer operating at a temperature of -35°C to -40°C or even lower, the aim is to lower the temperature in the warmest part of the fish, the **thermal centre** usually near the centre of the thickest part of the fish, as quickly as possible through the **thermal arrest** range to -20°C, so that the average temperature of the product leaving the freezer is at or below the recommended temperature of -30°C within 4 hours or less. This is known typically as **quick freezing** (sometimes called **rapid freezing**), but a precise definition is difficult. Another way of describing it is the recommendation for fish that the temperature range of the **thermal arrest** should be passed in 2 hours or less, but this period should be much shorter (minutes) for products of small unit size such as shrimp. In contrast, **slow freezing** describes a freezing process that is undesirably long. It is sometimes referred to as **sharp freezing**, as in the bad practice of blowing cold air around produce in a **cold store**, and it is a term to be avoided. The total time required to reduce the equilibrium temperature of the fish to that at which it is to be stored is the **freezing time**. Other imprecise terms used to describe the freezing process include **deep freezing** used especially in the context of **quick freezing**, to describe freezing of fish to a temperature of -18°C or below; **flash freezing**, refers to the **quick freezing** of small fish products such as shrimp, typically in a few minutes, and also called **snap freezing**. **Bulk freezing** refers to freezing loose unpackaged products or to freezing large quantities of fish for storage prior to further processing. **Individual quick freezing** (**IQF**) is the **quick freezing** of fish products, e.g. fillets, in such a manner that each unit of product remains separate when frozen, in contrast to a frozen block of product (e.g. **laminated block**). For methods of freezing or types of freezing equipment such as air blast, contact, fluidised bed, immersion and spray, see **freezer.**

Freezing point See **Freezing**

Freezing time See **Freezing**

Freezing tunnel, (**Tunnel freezer)** See **Freezer**

Freezing zone See **Freezing**

Fresh Describes the state, for fish, of being recently caught or harvested, and hence showing no signs of spoilage. A meaning, which should be discouraged, is the condition of not having been frozen; this meaning does not preclude the product's being stale. See **Freshness, Wet fish**.

Freshness A term that is not used with consistent meaning in fish technology. Most frequently is applied to the condition of fish throughout the complete sequence of changes during storage above freezing temperature in going from completely **fresh** to utterly spoiled. This sequence has two main successive stages. During the initial period of storage some of the characteristics of the **fresh** product reduce in intensity or are lost; in the later stage bacterial degradation of tissues, i.e. spoilage, becomes evident. It might be considered more correct to apply '**freshness**' only to the condition of fish in the first stage, and, say, 'staleness' to the condition in the later stage, but this makes for cumbersome terminology, and it would be more convenient to put pedantry aside and apply '**freshness**' to the condition during the complete sequence. **Freshness** is most accurately measured by sensory methods, though various chemical, microbiological, and physical tests have been proposed, studied, and occasionally applied in quality control as surrogates. (Botta, 1995)

Frozen at sea Fish frozen soon after capture, either onboard a fishing vessel with **freezing** plant (usually **vertical plate freezers**), such as a freezer trawler, or on a **factory ship** that is equipped to process its own catch onboard and/or the catch of other fishing vessels. See **Freezer**.

Frozen storage See **Cold store**

Gaping The separation of blocks of muscle in a raw fillet at the myocommata, the thin membrane that separates the blocks. In severe cases the fillet will fall apart. The propensity to gape differs markedly among species. Generally, **roundfish** gape more than flat fish, but there are important exceptions to this generalisation; ling (*Molva molva*) and catfish (*Anarhichas* sp.), for example, rarely show gaping.

Gaspé cure See **Salting**

Geosmin See **Earthy/muddy odours/flavours**.

Gibbing (Gipping) See **Gutting**

Glazing and Glaze, Glazed product Applying a protective coating of ice, an ice **glaze**, to unwrapped frozen fish, fillets, tailmeat of crustaceans, adductor muscle of scallops or other suitable frozen fish product, to reduce undesirable **drying** or **dehydration** of the fish during frozen or cold storage. Excessive **drying** during **frozen storage** results in **freezer burn**. The **glaze** is usually applied by dipping, spraying or brushing with water, which must be of drinking quality. The amount of **glaze** picked up by the product depends on the temperature of the fish, the temperature of the water, the size and shape of the product, its surface area, and the glazing time. The application of **glaze** is difficult to control and it is often applied in an uncontrolled way so that the amount added is not constant and the thickness is not uniform. Consequently, the amount of protection afforded by the **glaze** is unpredictable, and there can be problems with product specifications and the legal requirements for retail products concerning description of the **glazed product**, especially the declared **glazed weight**. See **Drained weight**.

Gloss The sheen on raw fillets and smoked fillets. The loss of gloss, especially in the gloss of smoked fillets, is an indication that the product has been held under poor frozen storage conditions.

Glycogen A complex carbohydrate found in animal tissues and acts as an energy reserve. It is present in the liver and muscle of fish and shellfish. It is readily converted in the muscle to glycogen which provides energy for muscle activity. The glycogen content of fish muscle is influenced by the nutritional status of the fish and is low when the fish is not feeding. On the death of the fish, the glycogen in the muscle is converted to lactic acid. This causes the **pH** of the muscle to drop from its typical value in the living animal of around 7.2. The drop in **pH** is particularly large in species such as tunas the muscles of which contain large amounts of glycogen.

Golden cutlet See **Filleting**

Gonads See **Gutting**

Grading The allocation of a defined category, or grade, of quality to a sample, or collection of similar samples, of a product. **Grading** can be, and usually is, done simultaneously with **sorting** though sorting can be done without grading. A grade can be defined as a single attribute of quality, for example size or freshness, or by some weighted function of several attributes. See **Sorting**, **EC grading**, **Demerit points**.

Greasy haddock, **Greasers** Haddock (*Melanogrammus aeglefinus*), especially smoked haddock, that have been infected with the organism *Ichthyophonus hoferi*, are known as a **greasers** or **greasy haddock**. The flesh of infected fish has a soft and greasy feel, and a sweet sickly smell. The fillets have a blotchy appearance which show as white spots in the smoked products. Infections by the organism are not confined to haddock; herring for example are similarly affected. *Ichthyophonus* is usually described as a fungus, but its true taxonomic position is not clear. (McVicar, 1999; Spangaard & Huss, 1996).

Greening A grey/green **discoloration** of canned tuna meat. The chemistry of the colour development is unclear, but **trimethylamine** and myoglobin are involved. A similar discoloration may occur in gas packed, sliced smoked salmon.

Gutting Removal by hand or by machine of the contents of the **gut cavity** or **belly cavity**, the guts, after slitting the fish open from throat to **vent**, to provide a **gutted** fish; also termed **eviscerating**. Fish without the guts removed are termed **ungutted**. The aim should be to thoroughly clean and wash out the belly cavity. To facilitate this, **roundfish** of sufficient size can be **double naped** (see **nape**) and the belly opened up over its entire length; care should be taken to remove the entire contents of the gut cavity including the liver. The **belly** or **gut cavity** is the compartment containing stomach, intestine and other internal organs known collectively as the guts and the gonads of a fish. The **guts** or **viscera** may refer to the entire contents of the belly cavity, or may represent the stomach, intestine and associated organs but exclude the liver and gonads. The **gonads** are the reproductive organs, the roe or hard roe in female and the milt or soft roe in male fish. The **long gut** is the stomach and intestine (especially of small fatty fish such as herring) which is pulled out while still attached to the head of the fish by **nobbing** to produce a nobbed fish; the head is partially severed and pulled without cutting open the belly so that the head and gut are removed in one operation, and the roe or milt is left in. In contrast, in the **gibbing** or **gipping** of fatty fish for **pickle curing**, the gills, long gut and stomach are removed in one operation, so that the roe or milt and some of the **pyloric caeca** remain. The latter are essential to obtain the desired flavour.

HACCP See **Hazard Analysis Critical Control Point**

Halophilic bacteria, **Halophiles** Bacteria that can grow in the present of salt, and perhaps requiring the presence of salt in order to grow. See **Pink**, **Water activity**.

Hard cure See **Heavy cure, Salting, Smoking, Drying**

Hard smoking (Hard cure) See **Smoking**

Hardwood Wood from deciduous trees, especially oak, that when burned produces smoke that imparts a more desirable flavour to fish than **softwood**. Oak is generally regarded as producing an excellent flavour but mahogany, hickory, cherry, apple and beech, amongst others, are also used. Wood treated with preservatives must not be used for smoking. See **Smoking** and **Smoking kiln**.

Hazard Analysis Critical Control Point (HACCP) A management system for eliminating, or at least, considerably reducing, the likelihood that unsafe products will be produced in a food handling or processing operation. The system seeks to analyse the processing operation, including any inputs, to identify and assess the hazards and risks associated with the operations or ingredients, to identify stages in the process where hazards can be controlled, and to establish monitoring and control points at stages where hazards can be controlled. It is a preventive approach that tries to ensure that unsafe foods are not produced as compared with control by **end-product inspection** which relies on detecting unfit products after manufacture. (Bryan, 1992; Codex Alimentarius, 1997; National Advisory Committee on Microbiological Criteria for Foods, 1998).

Heading Removal of the head by hand or by machine to give a headed, headless or beheaded fish. Various machines are available designed to behead specific species of fish either as a single operation or as part of a number of other cutting operations to suit particular products. Some **heading** machines are described as **V-cut** heading machines which refers to the type of angled head cut directly behind the **collar bone** as opposed to a **round-cut** or **straight-cut** heading machine. See **filleting**, **gutting**, and **heading and gutting**.

Heading and gutting (H&G) Removal by hand or by machine of both head and guts to produce **headed and gutted** (**H&G**) fish, especially in **white fish**, in preparation for freezing at sea, or for the processing of **klippfisk** (**klipfish**), and for the processing of tuna. For klipfish the **nape bone** or **collar bone** is retained on the fish. But, for other purposes the cut is made behind the **collar bone** which remains with the head, and the cut may be angled to remove varying portions of the **belly flaps**. These are the side walls of the **belly cavity**. The flap is usually still attached to a fillet when the **fillet** is removed during **filleting** of the fish; also called **flap**, **lug flap**, **wing**. See **Nape**.

Heat-treated (**heat-processing**) These terms apply to a variety of thermal treatments and processes. The heat-treated fish or shellfish may be ready-to-eat either hot or cold, it may require reheating or further cooking before eating, or it may be subject to further cooking as an ingredient in a composite product such as fish-in-sauce with vegetables, or fish pie. The degree of heat treatment received affects the microbiological status and stability of the product. Blanching or scalding are not intended to cook the fish but to aid removal of the skin or shell. Cooking of krill (*Euphausia* spp.) at 95°C for 1 to 3 minutes coagulates the protein, inhibits enzymic **autolysis** and **melanosis**, and subsequent cooling permits storage of the cooked krill for up to 5 days at 0°C before noticeable **spoilage** takes place. These mild heat treatments and others such as **pasteurisation** and **sous vide** processing will kill most vegetative bacteria, but not the heat resistant strains and spores. Growth of any surviving organisms is minimised by **chilled** or **frozen storage**, acidity, **salt** or some other controlling factor.
Molluscan shellfish harvested from sewage contaminated waters may contain bacterial **pathogens** as well as viruses that can cause gastroenteritis and hepatitis if contaminated shellfish are consumed. Under regulations adopted in Europe, for example, one option is that these shellfish be subjected to an approved **heat** (**thermal**) **process** in approved premises to ensure that microbiologically contaminated molluscs are rendered safe to eat. The approved **heat processes** are: **sterilisation** in hermetically sealed containers, i.e. **canning**; animals in the shell and not frozen are immersed in boiling water such that the internal temperature of the flesh is raised to at least 90°C, and this minimum temperature is maintained for at least 90 seconds; animals in the shell and not frozen are cooked for 3 to 5 minutes in an enclosed space in which the temperature is 120 to 160°C and the pressure is 2 to 4 kg/cm^2, followed by shelling and **freezing** of the flesh to a core temperature of -20°C.
Long term microbiological stability for non-dried products without the use of refrigeration is obtained by prolonged heating in hermetically sealed containers, such as **cans** or **retortable pouches**. The severity of the **heat process** is greater for low acid foods (**pH** greater than 4.5), which must receive a minimal **thermal process**, equivalent to a **botulinum cook**, sometimes called a full **heat sterilisation** process. Products manufactured in, or destined for, countries with hot climates may require a much more severe **thermal process**. See **Canning**.

Heat sterilisation See **Canning**

Heavy (Hard) cure Refers to the degree of **smoking**, **salting** or **drying**, or a combination of these processes, for preservation of the product.

Heavy smoking (heavy cure) See **Smoking**

Hedonic methods Experimental procedures used in sensory evaluation of foods in which assessors express their liking/disliking for samples in **rating** or in **discrimination** tests. In the former, a typical scale would be one ranging from 'like extremely' to 'dislike extremely'; in the latter, assessors would select the most liked, or disliked, from a pair of samples or would rank samples by the degree of liking for them.

Herring worm (**whale worm**) Common name given to parasitic **nematodes** of the genus ***Anisakis*** found in the flesh of herring, and other species of fish.

Hexa-metaphosphate A polymerised form of orthophosphate consisting of six condensed phosphate groups. Available under its trade name of Calgon. It is a **sequestrant** for calcium, and is included in detergents.

Hexamethylenetetramine Also called heaxamine. An antiseptic, it is generally not permitted as an **additive** in foods, though there may be exceptions for a very limited list of foods. But, it has been used as a **preservative** in marinated fishery products.

Hind gut See **Deveining**

Histamine, **Histamine poisoning**, **Histamine fish poisoning** Histamine is a **biogenic amine**. It is formed in fish muscle by decarboxylation of the **amino acid histidine** by bacteria. It is physiologically active and is released in allergic reactions such as hay fever when it is responsible for some of the symptoms of allergic responses. **Histamine** can reach high concentrations in muscles of fish after death that

contain high concentrations of **histidine**, typically, though not exclusively, members of the mackerel, tuna and herring families. The bacteria responsible for the deamination are not active below about 10ºC and chilling of the fish prevents production of histamine. **Histamine** is associated with **scombrotoxin poisoning**, though the aetiology of the illness is not completely clear. Food control regulations often specify the maximum concentration of histamine that may be permitted in fish and fish products for human consumption. See **Scombrotoxicosis**. (FAO, 1985; Lehane and Olley, 2000).

Histidine An **amino acid** found bound in proteins and in the free form in fish tissues. Can be decarboxylated by some bacteria to **histamine**.

Honeycombing A textural defect in tuna characterised by pitted, spongy-looking meat, generally localised near the head of the fish which appears on cooking the meat, for example, in the pre-cooking stage before packing during the canning of tuna. It is a result of time/temperature abuse, appearing in flesh that has started to decompose. **Off-odours** usually accompany the honeycombing.

Horizontal plate freezer See **Freezer**

Hot smoking See **Smoking**, **Smoking kiln**

Humidity See **Relative humidity**

Hydroperoxides See **Peroxide value**

Hygiene, Hygienic See **Food hygiene**

Hypoxanthine A compound formed by chemical reactions occurring in fish muscle after death of the fish. Its concentration in a sample of fish muscle is a measure of the **freshness** of the fish. (Botta, 1995). Also see ***K*-value**.

Ice See **Glazing**; see **Icing**

Icing Putting ice among fish, as in **boxing**, to chill it to 0 to -0.5°C. The ice may be derived from **block ice** (**cake ice**), i.e. ice made by freezing water in a mould to form a block typically weighing about 50 kg, which is stored whole and normally has to be crushed before use to give small irregularly shaped pieces known as **crushed ice**. The ice may be **small ice** produced in small pieces ready for use, as in the case of **flake ice,** which is probably the most suitable and widely used for chilling fish. This is produced by freezing a thin layer of water on a refrigerated cylinder, and scraping it off in fragments or flakes; also known as **scale ice** or **slice ice**. It may be **small ice** cut into small pieces immediately after manufacture, as in the case of **tube ice** made by freezing water inside vertical tubes, cut into short lengths immediately on release, and sometimes crushed before use. **Small ice** refers to the many kinds of ice made in small pieces in addition to those described above such as **snow** or **powder ice**, **plate ice**, **ribbon ice** and many others.

Weight for weight, the cooling capacity or refrigeration effect of **ice** is always the same for all practical purposes, irrespective of the origin of the **ice** (334.5 kJ/kg). A slushy mixture of **ice** and water (sometimes referred to as **slush ice**) should never be compared with an equal weight of **ice** alone. One kg of slushy **ice** has a lower cooling capacity than 1 kg of fresh crisp **ice**, to an extent that depends on the degree of wetness of the slush. One kg of **ice** at -5°C has only about 3% more cooling power than 1 kg of **ice** at 0°C. The quantity of **ice** required initially to cool a unit weight of fish from a given temperature (T°C) to 0°C is T divided by 80 times the specific heat of the fish. Additional **ice** is required to absorb the heat input from the surroundings in order to keep the mass of fish at the chill temperature. For example, in practice for cold water fisheries, 3 parts fish to 1 part **ice** by weight should be sufficient in properly iced boxes in a properly operated **fishroom** to cool the fish and leave sufficient ice after a 7 to 8 day trip to indicate to the buyer that the fish have been properly chilled. Warm water fisheries may require a ratio of 2:1 or even 1:1. **Binary ice**, known also as **flow ice** or **slurry ice**, is made from **brine** and is composed of very small ice crystals suspended in brine or seawater. The proportion of ice crystals and the **brine strength** can be varied to control the temperature of the mixture, which can lead to **superchilling** or **partial freezing** of the fish at temperatures less than -1°C. The mixture can be pumped if the ice fraction is 60% or less. Drained **binary ice** crystals are sometimes referred to confusingly as **snow ice**.

Immersion freezer See **Freezer**

Immersion thawing See **Thawing**

Indicator organism In the context of food hygiene, a microorganism, or group of microorganisms, which are not themselves considered to be harmful in the food, but whose presence might suggest that the food could have been contaminated by harmful microorganisms existing in the same environment as the indicator organism. The presence of the indicator organisms is tested for rather than the pathogenic organisms because it is simpler and quicker to test for them. The presence of indicator organisms, or presence in high numbers, in a product could prompt further testing for the pathogenic organisms, or could be a reason for rejecting the product. Examples of indicator organisms used in quality control of fishery products are **coliforms**, **faecal coliforms**, and ***Escherichia coli***.

Individual quick freezing (IQF) See **Freezing**

Initial freezing temperature See **Freezing**

Ink bag parasite. See **Blackening** (2).

In-plant chlorination The practice of adding chlorine into the water supply to a fish processing plant. The primary purpose is to ensure that products, premises and equipment are not contaminated with harmful waterborne microorganisms. The chlorine can be injected as chlorine gas or as solutions of hypochlorite. The gas or solutions are metered into the water supply according to the water flow. Sufficient chlorine should be added to achieve a low level of free chlorine. Some **Codes of Practice**, for example, those of the **Codex Alimentarius** Commission, allow concentrations of up to 10 mg/l of active chlorine, but many national regulations set maximum limits for water in contact with foods at much lower concentrations, often less than 1 mg/l, although there is no evidence of risk of harm at the higher level. (Codex Committee on Fish and Fishery Products, 2000).

Inspection The examination of a product to ascertain its compliance with the required **specification** of **quality**. Inspection can be 100%, that is inspection of all products passing an inspection point in a processing line or all items in a batch of product, or be based on sampling. Sampling inspection is typically applied to batches of products entering a process or stage in a process, to checking finished products before warehousing or despatch, or to checking finished products being accepted for marketing. The process of inspecting a batch and the action to be taken as a result of sampling and testing are described in a **sampling plan**.

Interleaving See **Shatterpack**

Intrinsic quality In the context of fishery products, the **quality** of the fish at the time of capture or harvesting. It will include attributes such as species, size, **condition**, **composition**, (especially **fat content**), damage, and presence of **parasites**, harmful **microorganisms**, **taints**, **toxins** and **contaminants**. (Connell, 1995).

Iodoform odour A slightly irritating odour similar to that of iodoform. It is detected occasionally in vertebrate fish and in crustaceans, more often in the latter. It is typically confined to particular fishing grounds and seasons. (Boyle *et al*., 1993; Whitfield *et al*., 1996).

IQF (**Individual quick freezing**) See **Freezing**

J-cutting (J-cut, J-cuts) An alternative to **V-cutting**. A simpler, but more extravagant way of cutting out most or all of the **pin bones**. A cut (the **J-cut**) is made through the skinned fillet from the neck end of the **fillet**, dorsal to and along the line of **pin bones** towards the last pin bone, and then curved sharply down to the ventral edge of the **belly flap**. The pieces cut out are the **J-cuts** (sometimes called **pin bone trimmings**) to leave a **J-cut** fillet. See **Filleting**, **Gutting**, and **Heading and gutting**.

Jelly condition A defect in the **texture** of fish muscle. The muscle has a translucent appearance, and the **texture** to the feel is soft and gelatinous. The cooked muscle has a soft **texture**. The jelly condition is

associated with flesh of low protein content, <12%, and high water content. The condition is more common in some species than others, fish from deep waters are especially prone to the condition, and nutritional status can affect the incidence; starving fish have a high incidence, well fed fish a low incidence.

***K*-value** An chemical index used as a measure of the freshness of fish. Adenosine triphosphate (ATP) present in fish muscle is converted on the death of the animal though a sequence of intermediates to **hypoxanthine** (Hy). The intermediates are, in sequence, adenosine diphosphate (ADP), adenosine monophosphate (AMP), inosine monophosphate (IMP), and inosine (Ino). *K*-value is defined as the ratio, (often multiplied by 100), of the sum of Ino and Hy contents to the sum of concentration of ATP and all degradation products, expressed on a molar basis. ATP is converted to IMP within a day or two after death of the animal, the fish being stored at 0ºC. The IMP is lost more slowly leaving just Ino and Hy, and the *K*-value approaches 1.0, (or 100). *K*-value is usually the best predictor of freshness measured either by time of storage or by sensory methods for many species of fish, including shellfish. The relationship between *K*-value and storage time or sensory freshness is not the same over all species of fish and must be determined for a particular species of interest. It is not a simple test to carry out and requires some analytical skills and expensive equipment, and has not found favour for quality control. It is probably used most widely in Japan. See **Nucleotides**.

Kamaboko See **Surimi**

Kench curing See **Salting**

Kiln May be used for smoking and/or drying. See **Smoking kiln**, **salting**.

Kipper and Kippering Herring **split** along the back, **brined**, sometimes dyed, and **cold smoked** to produce a product known as a **kipper**. The brown colouring used is referred to as kipper **dye** and is usually **brown FK**. A kipper fillet may be a cold smoked, single fillet of herring (which may then be canned), or a fillet cut from a so-called **boneless kipper** which used to be produced from a kipper from which the head, belly wall and backbone was removed. A **boneless kipper** is now usually regarded as a **cold smoked**, **block fillet** of herring. Confusingly, **kippering** may refer to production of **kippers** from herring or, in the UK, to the process of **splitting** a fish in the same manner as a herring and **cold smoking**, as well as generic reference to **cold smoking**, or to the process of **hot smoking** in the USA.

Kjeldahl method The most commonly used procedure for determining the **nitrogen content** of a sample. The sample is heated with concentrated sulphuric acid and a catalyst, commonly mercury, and the nitrogen is converted to ammonia. The digest is made alkaline, and the ammonia distilled off and measured. Named after the originator of the procedure.

Klippfisk (Klipfish) Norwegian name for **salted and dried** cod (*Gadus morhua*) made briefly as follows. Typically, it is bled, headed with a so-called **round cut** and **gutted**, **split** and cleaned to leave a piece of the backbone at the tail to give strength. The fish are stacked in layers with solid **salt**, eventually taking up salt to about 18% by weight, while the **saturated brine** formed is allowed to drain away. The fish are removed from the **stack**, **washed**, drained and hung up for **drying** for a few days, then restacked and hung up for **drying** a number of times to reduce the moisture content further, or dried in driers. See **Heading**, **Heading and gutting**, and **Salting**.

Klondyking Traditionally refers to the practice of preserving fish for a short time by cooling them in a mixture of ice and salt. Also used to describe the **transshipping** of fish at sea from a catcher vessel to a carrier vessel on which the fish were formerly, and sometimes still are, preserved as above, but are now more likely to be frozen, or otherwise processed.

***Kudoa* spp.** A genus of the zoological class Myxosporea found as **parasites** in the muscle tissue of many species of marine and freshwater vertebrate fish. Many species of *Kudoa* secrete a proteolytic enzyme to form, at the least, unsightly white cysts in the flesh and, in extreme cases, to result in softening and liquefaction of the flesh. The cysts become very obvious if the fillet is smoked. Some species of *Kudoa* are specific to particular species of fish, but *Kudoa thyrsites* is known to infect some 20 or more species, including economically important species such as salmons - wild and farmed - and Pacific hake. (In early papers on the milky condition of hake and other similar defects, the organism was

named as ***Chloromyxum thyrsites*** and described as a protozoan parasite. There has been revision of the taxonomy of *Kudoa* and similar parasites and they are now classed as metazoans and placed in their own phylum, Myxozoa). (Moran *et al*, 1999).

Lacquer See **Canning**

Laminated block A frozen, rectilinear, cuboidal block of closely controlled dimensions and weight, typically a nominal 7.4 kg, usually made from white fish as an intermediate product for the production of **fish fingers** (**fish sticks**) and portions. It is composed entirely of skinless, boneless fillets (**fillet block**), that may be jumble-packed or orientated and layered, or composed of skinless, boneless fillets plus the **recovered fish flesh** from the **V-cuts**, for example, or composed entirely of **recovered fish flesh** (**minced fish**), termed a **mince block** or **minced fish block**. A proprietary **polyphosphate** mixture is often added to the fillets and/or mince before packing. The blocks may be made at sea on **factory ships** or onshore. Originally, fish blocks were composed of layered, skinless, boneless fillets and termed **laminated blocks**, and produced for the purpose of manufacturing **fish sticks** (**fish fingers**). As demand expanded for fingers and portions, fish flesh recovered from **pin bone trimmings** by means of **bone separators** was mixed with the fillets in the block. Subsequently, **minced fish blocks** were made for economy and catering products. The blocks are formed typically by packing the fish in a one-piece, protective, waxed card carton folded inside a metal mould or frame on a tray, and compacted to eliminate **voids** or air spaces within the mass of fish . The cartons packed in the frames are frozen in a **horizontal plate freezer**, ejected from the frame after freezing in a **block press**, and packed usually in fours in a semi-rigid, cardboard **master carton** (**outer**), for storage and distribution at -30°C. The blocks are a common item of international trade in frozen fish products. Also see **V-cutting**.

Latent heat The heat lost or gained during a change of phase, for example, from liquid to solid during freezing or from solid to liquid during **thawing**. See **Freezing**

Lean fish Used in a number of contexts. It may refer to **white fish**, or to **spent fish**, i.e. fish that has recently spawned, usually in poor condition, or to recovering **spent fish**, or it may refer to **fatty fish** with a seasonally low fat content. More strictly, it may be defined as fish that contain 2% or less fat in the flesh in the live state.

Light box See **Candling**

Light cure Refers to the mild degree of **smoking** or **salting**

Lipid composition The components of a mixture of **lipids** or of the constituents of a particular lipids. The **fat** extracted from fish contains several components, such as triglyceride lipid, phospholipids, sterols, and others, which can be separated to give an analysis of the components of the lipid. More usually, but loosely, the term **lipid composition** refers to analysis of the lipid for the constituents **fatty acids**.

Lipids See **Fats**.

Liquid smoke See **Smoking**

Liquid nitrogen See **Freezer**

Listeria monocytogenes A species of bacteria pathogenic to humans. Listeriosis is the disease caused by infection by the organism. Its significance as a food pathogen has been realised only in the last two or three decades. It has a widespread occurrence in nature, being found in soils, vegetation, foods, including fishery products, internal environments of fish processing plants, and even commensally in humans. The route of infection is through the gut following consumption of contaminated food. Those most at risk are the foetus, pregnant women, neonates, the elderly, and immuno-compromised persons. Healthy persons are resistant to infection with no more than mild symptoms of gastrointestinal disturbance. At present, the number of organisms required to cause illness is not known. Fishery products have been implicated in incidents of listeriosis, but very rarely. The organism can grow at chill temperatures. Vigorous and rigorous sanitary and **disinfection** procedures are required to eliminate the organism from a fish processing plant. Other species of *Listeria* are often used as

indicator organisms for ***Listeria monocytogenes***, although they rarely cause food-borne illness. (Ben Embarek, 1994).

Loin See **Filleting**

London kiln See **Smoking kiln**

Long gut See **Gutting**, **Deveining**
Lug flap See **Heading and gutting**

Lug, Lug bone See **Nape**

Malondialdehyde A chemical formed in the **oxidation** of **lipids**. The **thiobarbituric acid** test measures its concentration in a sample of fish or extracted lipid and provides a measure of the degree of oxidation.

Marinating and marinades The preparation of **marinades**, typically involves the preservation of fish by treatment with solutions of dilute acid (usually **acetic acid** or vinegar) and **salt**, a process that gives the fish a characteristic flavour and texture. The **salt** contributes to the firmness of the flesh. In addition, the product is often seasoned with sugar, herbs and spices in the second stage of the process. Basically, there are two categories of marinade, **cold marinades** and **cooked marinades**, giving rise to a variety of products with different characteristics. Preservation of **cold marinades** depends entirely on the presence of acid and salt, but **cooked marinades** also involve some **heat treatment** and may be pasteurised. Shellfish are boiled to destroy the enzymes that would otherwise digest them during marinating. Unless the marinade is subsequently canned, or the equivalent, marinades are regarded as **semi-preserves**, and must be kept chilled, providing a shelf life of only about one to two months. The presence of acid is critical to preservation. The acid taste of the marinade can be reduced by substituting with citric or tartaric acid, or fermented vinegar, for some or all of the **acetic acid** but, the **pH** of the product must not exceed 4.5. At this **pH**, food poisoning bacteria and most spoilage organisms do not grow, but some bacteria and enzymes are still active and a small degree of **ripening** occurs which contributes to the texture and flavour.

Master carton See **Outer**

Maturing See **Ripening**

Mechanical briner See **Brining**

Mechanical kiln See **Smoking kiln**

Mechanically recovered fish flesh See **Minced fish**

Melanosis See **Black spot**.

Mesophiles, **Mesophilic bacteria** Members of a class of bacteria in a classification system based on the temperature range at which an organism can grow. **Mesophiles** have an optimum growth temperature, the temperature at which they multiply most rapidly, in the region of 30-40ºC. Food poisoning organisms are adapted to grow in the body of warm-blooded animals and are **mesophiles**, though some can grow at chill temperatures. See **Psychrophiles**, **Psychrophilic bacteria**.

Microbiological count See **Total viable count**

Microorganism Microscopic organisms, also called microbes, which include bacteria, viruses, fungi (moulds), algae, protozoans, and yeasts.

Microwave thawing See **Thawing**

Mince block (Minced fish block) See **Laminated block**

Minced fish (Minced fish meat, Minced meat, Fish mince, Mince) Fish flesh separated from skin and bone in a mechanical **bone separator**, frequently of the **perforated drum** and **squeezing belt** type. Also known as **mechanically recovered fish flesh**, **recovered fish flesh**, **boneless fish meat**, **deboned fish flesh**. **MRM** (**mechanically recovered meat**) is sometimes used but primarily refers to the beef or poultry industry. Fish or pieces of fish, such as filleting waste or fillet trimmings (e.g. **V-cuts** or **J-cuts**), are fed from a hopper to be pressed between a moving, flexible belt and the outside of a counter-rotating, perforated, stainless steel drum. Ideally, the material should be fed flesh-side (**cut surface**) to the drum. The flesh is squeezed through the perforations of the drum and removed from the inside by means of a fixed screw. The coarseness and texture of the **mince**, the colour of the product, and the yield of flesh, are affected by the diameter of the drum perforations, the pressure applied to the **squeezing belt**, and the raw material or trimmings being used. For different applications, the perforations may range from about 1 to 10 mm. Under ideal conditions, the skin and bones remain on the outside of the drum and are removed continuously as waste by a fixed scraping blade. Depending on the raw material used and the conditions applied, some skin and bone fragments may pass through with the **recovered flesh**. Also see **Comminuted**.

Moisture Synonymous with water content in the context of **proximate composition**.

Most Probable Number (**MPN**) See **Coliforms**, **Faecal coliforms**

MRM (mechanically recovered meat) See **Minced fish**

Multi-pass freezer See **Freezer**

Naked See **Coating**, **Fish finger**

Nape Referred to as the flesh exposed at the shoulders of a fish when the head is removed, or that part of the **belly flap** immediately adjacent to the **nape bone**, and also called **lug**. The shoulder is the thickest part of the flesh of a fish, just behind the head on either side of the backbone. The **nape bone** is the bone at the shoulder of a fish that forms the leading edge of a **belly flap**; also called **lug bone**, **shoulder bone** or **collar bone**.

Nematodes Also called **roundworms**. Members of a zoological phylum Nematoda widely distributed in nature in water and in soils. They are characterised by having an elongated body with a circular cross section. Many species are parasites, including in man. Fish harbour nematodes parasitic in man, the two most prevalent being the **cod worm** and the **herring worm**. (Deardorff, & Overstreet, 1991).

Neriseihin See **Surimi**

Nitrogen factor, nitrogen content A number used to convert the **nitrogen content** of a sample to protein content or to **fish content**. There are two values of relevance to fish technology. One is the factor that converts total **nitrogen content** to **protein content**. Conventionally a value of 6.25 is used and the **nitrogen content** is multiplied by this factor to give the protein content. See **protein content**. The other is a value that converts total nitrogen content to fish content. It is the average nitrogen content of flesh of the species of interest. It has a value of around 2.8 (varying with species and season), and the measured nitrogen content of a sample is divided by this factor to give the fish content of the sample. The latter sample is used by trading standards officers in the determination of the **fish content** of products.

Nitrogen freezer See **Freezer**

Nitrogenous extractives The nitrogen-containing compounds in a protein-free extract of fish tissue. Typical extractants are dilute solutions of trichloroacetic acid and 80% ethanol. The constituents of extracts of fish muscle include creatinine, **amino acids**, **trimethylamine oxide** and, in the case of elasmobranchs, **urea**.

Nobbing See **Gutting**

Norbixin See **Dye**

North kiln See **Smoking kiln**

n-series (fatty acids) See **ω(omega)-3 fatty acids**, **Polyunsaturated fatty acids**

Nucleotides A class of organic compounds whose molecular structure comprises a nitrogen-containing base linked to a sugar and a phosphate group. The nucleotide of interest for fish technology is adenosine triphosphate (ATP) which is central to many metabolic processes in cells including the reactions that result in contraction of muscles resulting in movement. On the death of the fish, ATP is degraded by a series of reactions (see ***K*-value**), and the first step, loss of ATP to adenosine diphosphate, is linked to the onset of ***rigor mortis***.

Off-flavour/odour Sometimes the words are not hyphenated. An unpleasant flavour or odour generated by, chemical, biochemical, or microbiological reactions occurring within the product. Examples are **spoilage** flavours and odours and **cold storage flavours**. See **Taint**. (ISO 5492).

Odour See **Flavour/odour**

Omega-3 fatty acids, omega-6 fatty acids An alternative naming system for **polyunsaturated fatty acids (PUFAs)**. The **omega** (ω) carbon atom in the molecule is that of the terminal methyl group corresponding to **n** in the other naming system (**n-series**). Thus, **omega** (ω)-3, for example, refers to the position of the first carbon atom counting from the terminal carbon, the third in this case, attached to a double bond.

Operating characteristics (OC) curve A plot showing the probability of acceptance of a batch of stated quality under a given **sampling plan**. The quality of the batch is defined by the proportion of **defectives** in the batch in the case of acceptance sampling, or the mean value of properties in the case of sampling by variables. (See **sampling plan**). Typically, the probabilities are calculated for set qualities over a range of qualities likely to be obtained for batches using various **sampling plans** so that **sampling plans** can be compared for their likelihoods of making wrong decisions - accepting batches that should have been rejected, and rejecting batches that should have been accepted. (Grant & Leavenworth, 1996).

Organoleptic Relating to the properties of a product that are capable of stimulating one or more senses. See **Sensory analysis/evaluation**.

Out-grade Category to be discarded in a **sorting** process.

Outer (master carton) Semi-rigid carton used, for example, to give additional protection to frozen fish packed in a flexible film, or **shatterpacks**, or **IQF** fillets, or a **retortable pouch**. Sometimes refers to a **master carton** used to hold a number of smaller packs or blocks, especially of frozen fish such as the **laminated block**.

Over-pressured retorting See **Canning**

Oxidation There are formal chemical definitions of oxidation, involving electron transfer and free radicle reactions but, in the context of fish technology, it can be considered as the chemical reaction in which oxygen combines with a compound. Most usually, the oxygen comes from air surrounding the product but, for some reactions, the oxygen can come from oxygen-containing compounds. The oxidation reaction most frequently encountered in fish technology is oxidation of unsaturated **fatty acids** in the free form or as combined in **lipids**. Oxidation in this case is only the first step in a series of reactions that result in a variety of reaction products which are often strongly flavoured and give rise to rancid flavours. See **Cold storage flavour**, **Rancidity**.

PAHs See **Polycyclic aromatic hydrocarbons**

Parasites Organisms that live in or on other organisms, referred to as the host, from which they derive their food. Ectoparasites live on, or attached to, the surface of the host, for example, sea lice and **anchor worms**; endoparasites live within the host. The latter encompass those such as **nematodes** and

trematodes which cause disease in humans. Some parasites can complete their whole life cycle within one host, but those of public health concern need two or three different hosts to complete the life cycle. The host in which a parasite matures and produces eggs is the definitive host, the others are intermediate hosts. (Deardorff, & Overstreet, 1991). See **Blackening**.

Partial freezing See **Superchilling**

Pasteurisation A form of heat treatment that kills vegetative **pathogens** and most but not all spoilage microorganisms in foods. Typically, a fish product is **heat-treated** in water at 70 to 90°C for 5 to 10 minutes, so that a high proportion of spoilage and pathogenic micro-organisms is destroyed, thus extending chilled storage life. **Pasteurisation** can be used in combination with acid foods to reduce the severity of the heat process and minimise its effects on taste and texture. For example, mussel meats packed, covered in acetic acid, in closed jars, such that the acid content of the pack is not less than 1.8% and the pH is not higher than 4.2, may be processed so that the **thermal centre** (**cold spot**) of the jar is raised to 70°C and held at that temperature for 20 minutes, will have a shelf life of about 6 months at ambient temperature. See **Heat-treated** (**heat-processing**)

Pathogens An organism that is capable of causing disease, directly or by excreting a toxin. Examples are viruses, **bacteria**, **parasites**, moulds.

Pellicle Glossy film formed on the cut surface of the fish during **dripping**, due mainly to the swelling of protein under the influence of **brine** and subsequent surface drying in the **smoking kiln**.

Pepsin digestibility Test used in assessing the quality of fish meal which is meant to mimic to some extent digestion conditions in the stomach of animals. A sample of finely ground meal is treated with pepsin, a **proteolytic** enzyme from the stomach, under standard conditions, and the amount of protein digested from the sample is a measure of the nutritional availabilty of protein in the fish meal. See **Proteolysis**.

Perforated drum See **Minced fish**

Peroxide value An index of the extent of **oxidation** of a **lipid** in the early stages of **oxidation**. The initial step of **oxidation** of lipid is for oxygen to attach to unsaturated bonds in the molecule to form a **hydroperoxide**, which later breaks down to other products. The **peroxide value** measures this initial formation of **hydroperoxides**. Its value increases then decreases as **oxidation** proceeds, as the **hydroperoxides** are first formed then decomposed. A common way of measuring **peroxide value** is to react the lipid with potassium iodide and measure the amount of iodine liberated from the potassium iodide by peroxides in the lipid.

pH Formally defined as the negative logarithm of the molar concentration of hydrogen ions in solution. It is a measure of the acidity or alkalinity of a solution. pH 7 is neutral, and the pH of very pure water. A solution with a pH less than 7 is acidic, and one with pH above 7 is alkaline. The pH of fish muscle in live fish is around 7.2; after the death of the animal and resolution of ***rigor mortis***, the typical pH of most species of fish drops to between 6.4 and 6.9. In some species, for example, tunas, salmon, some species of halibut, the pH drops to 6 or lower. The pH of stored fish tends to rise as **amines** are formed during spoilage.

Phenols Aromatic compounds present in **wood smoke** that are mainly responsible for reducing bacterial spoilage in **smoked fish**. Measurement of phenols can serve as a rough check on a **smoking** process.

Phocanema decipiens See **Cod worm**.

Phospholipids A class of **lipids**. They are esters of glycerol, as are triglyceride lipids (triacylglycerols), but in phospholipids only two of the glycerol hydroxy groups are esterified with fatty acids, the third by a compound containing a phosphate group. They are incorporated into cell walls and membranes of structures within the cell. The **phospholipid** content of fish muscle, **lean** and **fatty fish**, is typically in the range 0.5-1.0%. The remainder of the **fat content** is triglyceride lipid. See **Fats**.

Pickling (pickle curing), pickle See **Salting, Brining** and M**arinating**

Pin bones See **Filleting**, **V-cutting** and **J-cutting**

Pin bone trimmings See **V-cutting** and **J-cutting**

Pink Pink **discoloration** of salted fish, and of salt and brines, caused by **halophilic bacteria**. Eventually, salted fish attacked by these bacteria go brownish, soften, and develop a foul odour.

Pink patches See **Canning**

Plastic box See **Boxing**

Plastic can See **Canning**

Plate freezer See **Freezer**

Plate ice See **Icing**

Platyhelminths Members of the zoological phylum Platyhelminthes, a group of soft-bodied, usually much flattened invertebrates. A trivial name is **flatworms** referring to their shape.
The phylum includes the **trematodes** (flukes) and **cestodes** (tapeworms), parasites of man and animals transmitted by fish or crustacean shellfish. (Deardorff, & Overstreet, 1991).

Polycyclic aromatic hydrocarbons (PAHs) A complex group of aromatic hydrocarbons containing 2 to 6 benzene rings that may have aliphatic and/or alicyclic hydrocarbon substituents. The parent compounds range from naphthalene to anthanthrene. They are found in many foods as environmental contaminants at low concentrations, including fish and shellfish, for which selected total 3 to 5 ring compounds in the edible parts are generally within the range from 0.1 to 50 mg/kg from non-industrialised areas. Lipid rich tissues may have concentrations up to 10 times that in lean muscle. PAHs are also found in fisheries by-products such as fish meal, fish oil and supplements derived from fish oils. In fish and shellfish exposed to environmental sources of PAHs such as industrially polluted sediments or spilled petroleum and petroleum products, the concentrations may be enhanced considerably by up to 1000 fold, particularly if exposure is acute. Once the source is removed the contaminants are slowly lost by the living animal. In crustaceans and bivalve molluscs the bioconcentration factors with respect to water for the higher ring PAHs are generally in the range 3000-6000, compared with fish which are generally less than 500. PAHs are produced during pyrolysis, and so methods of cooking and preparation of food such as barbecuing, grilling, broiling and frying tend to increase the concentration of PAHs.
PAHs are invariably found in **smoked fish** products at concentrations up to about 10 times or more of those in unsmoked products depending on the degree of exposure to smoke. They are deposited from the smoke in which more than 200 PAHs have been identified at concentrations and combinations that depend on the type of wood and the temperature of smouldering. Some of the PAHs are human carcinogens, co-carcinogens, teratogens and mutagens, and so selected compounds are subject to surveillance in foods as part of food safety and environmental programmes. About 16 two to five ring PAHs have been identified as priority environmental pollutants. Most of these have been assessed in a range of smoked fisheries products, but the PAHs selected depend on the availability and type of sophisticated equipment used for trace analysis and identification. Consequently, when total PAH concentrations are quoted it is very important to identify the component compounds in the analysis to compare data from different sources. Historically, most information is available on the presence of **benzo[*a*]pyrene** in fisheries products which, together with **dibenzo[*a,h*]anthracene**, represents the most potent of the probable human carcinogens. Sometimes the total carcinogenic PAHs measured are expressed as **benzo[*a*]pyrene** equivalents. The highest concentrations of PAHs can be expected in **heavily smoked** traditional products; up to 10 times more **benzo[*a*]pyrene** may be deposited during **hot smoking** compared with **cold smoking** and up to 10 times more **benzo[*a*]pyrene** may be deposited on the product (about 1 mg/kg) in a traditional **smokehouse** compared with a modern **kiln** in which the smoke is recirculated (about 0.1 mg/kg). The use of **liquid smoke** products in which the PAHs have been removed or reduced is effective in reducing the PAH concentrations of **smoke flavoured** foods. See **Smoking** and **Smoking kiln**.

Polyphosphates Polymerised phosphates prepared by heating orthophosphates. The degree of polymerisation varies with production conditions, but the mixture often used in fish processing is predominately **tripolyphosphate**. Generally approved as a food **additive** and is used as a dip for fillets to reduce **drip** in prepacked fish and from **thawed** fish. Also added to **surimi**.

Polyunsaturated fatty acids (PUFAs) The lipids of marine organisms are characterised by the presence of polyenoic fatty acids containing 16 to 22 carbon atoms with 2 to 6 conjugated double (ethene) bonds which originate from unicellular marine phytoplankton. Of particular interest, because of their essential benefits to human nutrition and health, are the long chain polyunsaturated fatty acids, **eicosapentaenoic acid** (**EPA**), which has 20 carbon atoms in the chain and 5 double bonds (denoted 20:5), and **docosahexaenoic acid** (22:6) or (**DHA**). The double bonds have the *cis* configuration which confers greater instability and lower melting point than the *trans* configuration. Thus, the correct chemical notation is *cis*-5,8,11,14,17-eicosapentaenoic acid and *cis*-4,7,10,13,16,19-docosahexaenoic acid. These acids are usually the major PUFA constituents of fish **lipids** and fish oils, and belong to the **n**-3 (**ω**-3) series in which the first double bond is at the third carbon atom along the chain from the terminal methyl group. They are considered to be important *inter alia* in relation to cardiovascular disease, inflammatory diseases and cancer, and **DHA** is important for normal post-natal development of cerebral and visual tissues. There is a wide range of fish oil supplements available for retail sale containing approximately 12% **DHA** and 18% **EPA**. Also see **ω(omega)-3 fatty acids**.

Porracaecum decipiens See **Cod worm**.

Powder ice See **Icing**

Predictive microbiology A branch of microbiology that studies the use mathematical modelling techniques to predict the growth of **microorganisms** in foods or in other substrates. (McMeekin *et al.*, 1993).

Preservative **Additives** that extend the storage lives of foods either by inhibiting growth of **microorganisms** and hence delaying **spoilage**, or by inhibiting chemical reactions that produce unwanted sensory changes in the product. An example of the latter in the context of fish processing is the use of sulphites to inhibit development of **black spot** in chill stored crustaceans. **Preservatives** are not used, or permitted in many countries, for preservation of **chill**- or **frozen**- stored raw fish or fish products, but are permitted for use in some **semi-preserves** such as **marinades** and in **dried fish**.

Pro-oxidant A substance that promotes oxidation of lipids. **Salt** is an example in fish technology.

Process value See **Canning** and **Commercial sterility**

Processing specification One of the documents that contributes to the quality assurance programme of a processing plant or company. It is the formalised description of necessary procedures for the manufacture of a product of the required **quality**. It can be used of itself or in conjunction with an **end-product** specification of a product. A **processing specification** can describe those processing steps that are important for the quality of the **end-product** when it is not easy to specify the necessary quality attributes, or to monitor them, or measure them in the end-product. An example would be in the production of a **smoked** product. The conditions for **brining** and **smoking** would be specified - amount of **salt** or **brine strength**, **brining time**, time and temperature of **smoking**, **smoke density**, nature of wood used as source of **smoke** - to achieve the right **flavour** and **texture** in the **end-product**.

Processors end See **Canning**

Protein content It is not easy to measure the true **protein content** of fish products. There are a large number of proteins in fish tissues, and it is not possible to have a reasonably simple procedure to determine them as a group of constituents. What is normally given as the **protein content** of fish products - and of foods generally - is the 'crude protein' content. This is based on the fact that all proteins contain nitrogen and measurement of total nitrogen is an estimate of the amount of protein in a sample. The **nitrogen content** is commonly measured by the **Kjehldahl method**. The crude protein content is not a very accurate measure of the true **protein content** of fish products for two principle reasons. One is that not all of the nitrogen-containing compounds in the product are proteins; about 85% is true protein. However, much of the non-protein material consists of **amino acids**, which are constituents of proteins

and, more-or-less, nutritionally equivalent Thus, this error in the context of nutritional labelling is not all that important. The other reason is that the **nitrogen content** is converted to **protein content** by dividing it by the nitrogen content of protein, (or more conventionally by multiplying it by the reciprocal of the nitrogen content). The **nitrogen content** of a protein is not the same for all proteins and a **crude protein content** is conventionally obtained by multiplying the total nitrogen content by 6.25. This factor is higher than the true value for muscle proteins as a group, and protein content estimated in this way overestimates slightly the true protein content. See **Nitrogen factor**.

Protein solubility The amount of protein in a sample of fish muscle that can be brought into solution under specified conditions of solvent and procedure. It is used especially as an index of damage to fish muscle structure and proteins incurred by frozen storage. Its value decreases with frozen storage at rates that depend on storage temperature; the lower the temperature, the slower the rate. Some 20-25% of the proteins in fish muscle can be solubilised by simple extraction of minced fish muscle with water. A further 65-70% can be solubilised by gently stirring or blending minced fish muscle in 0.5% salt solution at slightly alkaline pH, about 7.5. The solubilised fraction is separated from the insoluble fraction, usually by centrifugation, the **protein content** of each is measured, and the protein in the soluble fraction expressed as a percentage of the total.

Proteolysis The breaking down of proteins to their consitituent **amino acids** by enzymes. Proteins can be broken down to **amino acids** by the action of acids and alkalis, but this process is better referred to as hydrolysis. Organs in the gut of fish, for example, the **pyloric caeca**, excrete **proteolytic** enzymes, (proteases), which assist in the digestion of food, and muscle tissue contains proteases called cathepsins.

Proximate composition The main constituents of a product, and their amounts in unit mass or volume. In the case of products without added components, proximate composition typically comprises water, protein, fat, and ash, expressed as percentage of the weight. See **water content**, **protein content**, **fat**, and **ash** for procedures for determining these components and comments. These components usually sum to over 100%, typically around 101-102%, in fish muscle tissue. This is mainly due to the way **protein content** is measured, which slightly overestimates the true protein content. (See **protein content**). Packaged products for retail sale will list the proximate composition, usually not including ash, on the package. Packaged products with added ingredients will include the carbohydrate content in the list as appropriate. Carbohydrate content is usually calculated by difference, that is, by subtracting the sum of water, protein, fat and ash, as percentages, from 100. (FAO, 1991).

Pseudoterranova decipiens See **Cod worm**.

Psychrophiles, **Psychrophilic** or **Psychrotrophic bacteria** Bacteria with optimum growth temperatures in the region 10-15ºC and capable of growth down to 0ºC. (See **Mesophiles**). The bacteria growing on fish spoiling in ice are predominately **psychrophilic**.

PUFA See **Polyunsaturated fatty acids**

Puffer fish poisoning See **Tetrodotoxin**

Putty fish A defect in salted fish in which the flesh, more so in thicker parts of the fish, has a soft and plastic **texture**. It happens when thick fish are salted at high temperature so that parts of the fish spoil before the salt has penetrated to prevent spoilage. See **Salting**.

Pyloric caeca (pleural) Hollow finger like pouches in bony fish, in which proteolytic digestive enzymes are secreted, attached to the intestine near to the bottom (posterior end) of the stomach. See **Proteolysis**.

Pyrophosphates Salts formed by the condensation of two molecules of orthophosphate. (See **polyphosphates**).

QIM see **Quality Index Method**

Quality The totality of the features and characteristics of a product that bear on its ability to satisfy a given need, (ISO 8402-1995). In the case of a fishery product, quality is the aggregate of the properties that

influence the **acceptability** of the product for the consumer. These properties are predominately the particular properties that influence the **sensory properties** of the product - **appearance**, **flavour/odour**, **texture**. Merchants and processors must take account of these properties when marketing or processing fishery products, but other properties related to the processing of the products will be taken into account, for example, size, **condition**, presentation - whole, headed and gutted - frozen or not, season, fat content, fishing ground. These properties might influence the sensory properties, but are not directly apparent to the consumer. Merchants and processors might prepare a **specification** of quality for buying or selling products.

Quality assurance All the activities and functions concerned with the attainment and maintenance of **quality**, (ISO 8402-1995). Quality assurance refers to the management systems in a company for attaining and maintaining **quality**, and not to the operating systems. It will include such matters as recruitment and training of staff, documenting **specifications**, **codes of practice** and operating procedures, preparing **HACCP** plans, developing and maintaining records of operational practices, and of **quality control** for management purposes and for inspection by customers and regulatory authorities.

Quality control All activities and functions concerned with the attainment of **quality**. It is an active process in which quality controllers monitor handling, processing, storage and distribution systems, and intervene as necessary by selecting appropriate raw materials, modifying the process and withdrawing out-of-specification material to ensure the **end-products** meet the required **specifications** for **quality**.

Quality Index Method (QIM) A **demerit points** system for rating the **quality** of fish products. A system was first developed in New Zealand, but it has been adopted in recent years by laboratories in Europe and Scandinavia. The method has been developed mostly for raw, chilled fish, but systems exist for frozen fish. (Larsen *et al*., 1992).

Quick freezing see **Freezing**

Rancid, rancidity Rancid describes the harsh, somewhat bitter, **flavour** and **odour** of oxidised fats. **Rancidity** is the **quality** of being rancid. **Oxidation** of fats results in a variety of chemicals of different types, many of which have strong odours and flavours. These give rise to the **rancid** sensation. Because **rancid** flavours are due to mixtures of chemicals, the exact character of **rancidity** can differ a little among sources of the fat and the extent of oxidation.

Rapid freezing see **Freezing**

Recovered fish flesh (Recovered flesh, Recovered fish) See **Minced fish**

Refiner/strainer See **Surimi**

Refreezing Freezing fish again after it has been **thawed** or partially thawed as in **tempering**.

Refrigerant The working fluid of a refrigeration system that directly or indirectly extracts and carries away heat from a product or space being cooled. The primary refrigerant in a system takes up the heat in an evaporator or heat exchanger and discharges it in a condenser. The secondary refrigerant is the intermediate fluid in the system, cooled in a heat exchanger by the primary refrigerant, and used to actually cool the product or space. See **Freezant**.

Refrigerated sea water (RSW) Sea water in fixed tanks chilled by mechanical refrigeration, especially at sea installed in the hold, for quickly and uniformly **chilling** pelagic fish, in particular, by immersion. In a full tank the proportion of sea water to fish should be between 1:3 and 1:2 and the water is circulated by pump to maintain a uniform temperature and prevent temperature stratification. The sea water in the tank should be pre-cooled before fish are loaded. The sea water can be lowered to about -1°C without freezing the fish to obtain the maximum benefit, and the catch can be cooled more rapidly than by stowage in **ice**. The refrigeration capacity of an **RSW** system should be sufficient to cool the fish to 0°C within a few hours. Some species take up unacceptable amounts of water and salt when kept in sea water, the eyes become cloudy and the gills are bleached as the blood is leached out. Consequently, stowage in **RSW** is usually limited to a maximum of 3 to 4 days. **RSW** systems should be designed specifically to suit both the vessel and the fishery.

Relative humidity (**rh**) The ratio of the amount of moisture or water vapour (**vapour pressure**) in the air (the **humidity**) to the total moisture that the air could hold at that temperature, i.e. saturated with water vapour (**saturation vapour pressure**), is the **relative humidity**. It is usually expressed as a percentage and abbreviated to **rh**. Air saturated with water vapour has a **relative humidity** of 100% and when only half saturated the **rh** is 50%. In UK experience, an **rh** of 69 to 70% is satisfactory for cold smoking; see **Smoking**, **Smoking kiln**.

Regulatory standards **Standards** that are incorporated into legislation or are issued by a regulatory body.

Retortable pouch See **Canning**

rh See **Relative humidity**.

Rheology The study of flow properties of materials. These properties include viscosity, plasticity, hardness, toughness, elasticity, i.e. all are properties that have a bearing on the **texture** of fish products. **Rheology** involves the measurement of textural properties by instrumental, not sensory, methods. (Rosenthal, 1999).

Ribbon blender See **Surimi**

Ribbon ice See **Icing**

Rigor mortis*, Rigor** *Rigor mortis* is the Latin term for stiffness of death; the stiffening of an animal body after death. Because it is a Latin term it is conventional to italicise 'rgor mortis***'; '**rigor**', (not to be confused with the American spelling of 'rigour'), exists as a term meaning stiffness and is not usually italicised. Typically, vertebrate fish start to go into rigor 8-24 hours after death, but this period can be shorter or longer, and rigor is resolved after a further 1-3 days. Time into, time in, and strength of rigor varies with several factors, the main ones being species, nutritional status, amount of exercise by the fish immediately before death, and the ambient temperature of the fish.

Ripening Ripening or **maturing** of small fatty species such as anchovy and herring with salt, sugar, and sometimes spices, in barrels, in order to obtain characteristic changes in texture and flavour, is a complex process which takes several months. It is thought to involve degradation of proteins and lipids in the fish muscle by enzymes from the digestive tract, especially from the **pyloric caeca**, and to be seasonally dependent particularly in herring (*Clupea harengus*). The products are **semi-preserves** and must be kept chilled. See **Salting** and **Marinating**.

Ropy brine A defect in **pickling brines** that contain sugars. Bacteria can convert the sugars to a polysaccharide giving a stringy, slimy consistency to the **brine**. See **Brining**.

Round-cut See **Heading**, **Klippfisk**

Roundfish (**rounder**) Sometimes written **Round fish**. May refer to a **whole**, **ungutted** fish (also known as a **rounder**), or to fish that have a roughly round cross section of the body, such as cod (*Gadus morhua*), as compared with a flatfish such as plaice (*Pleuronectes platessa*).

Roundworms See **Nematodes**.

RSW See **Refrigerated sea water**

Salimeter (**Salinometer**) See **Brine**

Salmonella A genus of Gram negative, carbohydrate fermenting, non-spore forming **bacteria** of faecal origin. They can survive and may grow well in factory environments. The majority of strains are regarded as potentially pathogenic to humans. They cause an infective type of **food poisoning**, i.e. they multiply in the body. Consequently, only a small numbers of cells need to be present in the contaminated food. Salmonellosis is the illness caused by ***Salmonella*** bacteria. The illness is typical of a gastrointestinal infection - onset 12-36 hours after consumption of the food, with symptoms of diarrhoea, abdominal pain, fever, nausea, vomiting. The organisms are not indigenous to the aquatic environment, but can be

found there following contamination with animal, including human, faeces. They are not normally present in fish and shellfish and are not often found in fresh fish products, but can be found in molluscan shellfish taken from waters, especially inshore waters, that have become contaminated with sewage. The Salmonellae along with other bacteria and viruses become concentrated in the gut of these filter-feeding molluscs. Fish from unpolluted waters do not harbour the bacteria, but can become carriers if caught or harvested from polluted waters, and products after harvesting can become contaminated in unsanitary surroundings. (Ahmed, 1991; FAO, 1994).

Salt Defined chemically, salts are ionic compounds in which the cation comes from a base and the anion comes from an acid, e.g. sodium chloride, calcium chloride. Solutions of these salts, or **brines**, are used for **brine freezing** fish such as tuna in a **brine immersion freezer**. **Sodium chloride** is also known as **common salt**. It is the source of a basic taste. Salt **curing** is a traditional method of preserving both **white fish** and **fatty fish**. Three main types of **salt** are used commercially, rock or mined salt from underground deposits, evaporation of strong brines pumped from deep mines, and solar salt by solar evaporation from sea water or inland salt lakes. For modern food products, it is preferable to use purified, manufactured, **vacuum dried salt** that can be produced from the types described above. Salt is used for **dry salting** fish or, in solution as a **brine**, for **brining** fish prior to **smoking**, **drying**, **canning** or some other form of processing that requires a **brining** stage. Solid **salt** is also used for **pickle curing**, the traditional way of preserving **fatty fish** in airtight barrels. The purity of the salt used for **curing** affects the curing process and the characteristics of the cured product, particularly in **dry salting**.

Salt-boiled fish Cooking in **brine** may be used as a preliminary treatment before further processing, such as **canning**, or for the initial handling of some crustaceans such as shrimp by boiling in sea water. In southeast Asia, **salt-boiled fish** is an important commercial process and the amount of **salt** used determines the shelf life of the product. Boiling inactivates enzymes and kills most but not all non-spore forming micro-organisms and alone gives no more than 1 or 2 days shelf life at the ambient temperature. Storage up to 3 months under tropical conditions can be achieved if the fish are cooked in **salt** until there is no free water left in the bottom of the pan, the surface of the fish in the pot is covered with a thick layer of **salt**, and the pot is sealed with paper. Similarly cooked and covered in a glass jar with an effective closure and sealing ring can extend the storage life up to 9 months.

Salt concentration For food safety reasons, particularly to consider the potential growth of pathogenic microorganisms in **smoked fish** products intended to be eaten without further cooking, it is important to know the **salt concentration** in the product as distinct from the **salt content**. In **smoked fish**, **salt concentration** is the percentage weight of **salt** in the water phase of the product. Both **water content** and **salt content** must be measured. The percentage **salt concentration** is calculated as salt content divided by salt content plus water content multiplied by 100. See **Smoking**

Salt content The weight of salt in a given weight of fish, for example in a **smoked fish** product, usually expressed as g salt/100 g fish, or as a percentage and, importantly, distinguished from the **salt concentration**. See **Smoking**

Salt curing See **Salting**

Salted and dried (salted dried; dried salt; dried salted) See **Salting**

Salting Addition of **salt** or salting may only be required to flavour a product prior to further processing such as **smoking** or **canning**. This is carried out by **brining** or **dry salting** for a short time. In **salt curing** the fish is in contact with a high concentration of **salt** for a long time. The aim is to increase the concentration of solutes in the flesh, remove water and lower the **water activity**, but long-term preservation is only possible if the salt concentration in the flesh reaches concentrations corresponding to a **saturated brine** and a **water activity** of 0.75.

Salt cured products remain important in many parts of the world. Salting may be **dry salting** in which fish, usually **split** or as **sides**, are stacked or covered in solid salt and the **brine** formed is allowed to flow away, or **wet salting** by immersion in a strong brine or **pickle**, i.e. **pickling**. However, a common traditional method, particularly for herring and other fatty fish, is to bury the fish in dry **salt** in air tight barrels or containers so that the fish subsequently becomes immersed in the liquid **pickle** formed by solution of the **salt** in the liquid extracted from the fish. The liquid pickle is termed the **blood pickle**.

A lighter cure using 80 to 90% **saturated brine** is used for herring for the matjés cure to give a soft texture and characteristic flavour. It has a lower salt content and has to be kept chilled because it spoils readily at higher temperatures. Fish may be salted whole and **ungutted**, partially gutted (**gibbing**), **gutted** and **split**, or as **sides**, **fillets**, fillet pieces or as minced fish, depending on size of fish and product required. Only small fatty fish such as anchovy are salted whole because the skin is a barrier to salt penetration such that whole larger fish spoil at the centre before salt can reach the centre. **Scoring** of fillets and sides of larger fish is used to aid salt penetration. Generally, **pickling** in concentrated brines for long periods is used for long term preservation of fatty fish. Immersion in a full air tight container restricts the presence of oxygen, retards oxidation reactions and development of **rancidity**, although some **rancidity** is essential to the development of the characteristic flavour of the product. Some products depend on the presence of proteolytic enzymes in the guts, or part of the guts (e.g. part of the **pyloric caeca**), to develop the characteristic flavour, texture and colour of the particular product by the complex process of **maturing** (or **ripening**) during **pickling**, e.g. matjés herring, and also depends on the seasonal condition of the fish before processing.
Split white fish, opened flat and laid in layers between layers of salt, such that the liquor formed is allowed to drain away is called **kench curing**. This can be done onshore or at sea on the fishing grounds. Onshore, the fish are restacked a number of times to produce an even cure in the **wet stack**, and then dried in the open in the wind and sun, or artificially in a drier or drying kiln, to produce a dry and white product ranging from 10 to 30% moisture. Typically, fish produced to a **biscuit cure** after **drying** have a water content of 25% and a salt content of 26%. The **salted and dried** (**salted dried**; **dried salt**; **dried salted**) product is known as a **heavy cure** or **hard cure**, and has a long shelf life. However, at relative humidity of air above 76%, solid **salt**, and therefore **dried salt** fish, absorbs water and, under these conditions, **salted and dried** fish spoils. **Dry salting** of **split**, **white fish** carried out in tubs in which the fish are weighted to keep them immersed for 2 to 3 days in the brine liquor formed and then dried in the sun or in drying kilns is termed a **light cure** or **Gaspé cure**. The product is less heavily salted, has a cheesy taste and amber coloured translucent flesh. See **Brining**, **Klippfisk** , **Putty fish** and **White spot**.

Sample, Sampling A **sample** is a set of items taken from a larger set of items which is intended to reflect the properties of the larger set. **Sampling** is the process of taking a sample. The properties of items in the sample are measured, and the properties of the larger set are deduced from the properties of the **sample**.

Sampling plan An element of the practice of statistical **quality control** especially in the examination of batches of product. It is the set of instructions for sampling and testing the batch, and coming to a decision about the fate of the batch as a result of the sampling and testing. A typical **sampling plan** would have a series of actions. First, the batch for decision making is defined. This should be a set of items of similar characteristics, for example, the products prepared in a shift, or contained in a delivery. The decision rules will state the number of items to be taken as a **sample**, and how they should be drawn from the batch. The sample units are tested according to a stated test protocol and the results of the tests compared against a specification for the product. In attribute **sampling**, each item in the **sample** is defined as **defective** or effective, that is, meeting the specification or, in three class sampling plans, being in a marginal class, on the basis of the test protocol. The **sampling plan** will state the maximum number of items in the sample that may be **defective**, or maximum numbers in each of **defective** and marginal classes, in the case of three class **sampling plans**, for the batch as a whole to be accepted. These are the decision rules. In sampling by variable **sampling plans**, the properties are measured on a continuous scale and the mean values obtained for the sample items are compared with the specification. A batch will be accepted or rejected according to how the mean values compare with control values in the specification. (Grant & Leavenworth, 1996).

Sanitation The application of procedures for achieving and maintaining the cleanliness of premises and equipment, especially in the context of preventing contamination of food products by noxious agents. A sanitary programme for a fish processing plant will include the location and design of premises to reduce the risk of contamination. To facilitate cleaning, it will include the design and construction of equipment to ensure they can be cleaned and disinfected. It will include the control of pests, the disposal of solid and liquid wastes, provision of facilities for personnel hygiene, provision of facilities for the safe and separate storage, of raw materials, finished products, and materials used in the processes. The management of the plant must institute procedures for maintaining the sanitation of

premises and equipment by regular programmes of cleaning and **disinfection**. (Codex Alimentarius Commission, 1997)

Saturation vapour pressure See **Relative humidity**

Saturated brine See **brine**

Sawdust Tiny particles of wood produced during sawing that are burned to generate **smoke** for fish **smoking**. See **wood chips** and **smoking kiln**.

Scale ice See **Icing**

Scales (1). Apparatus for measuring the weight of an object.
(2). In **sensory evaluation**, a mathematical representation of the perceived intensity of an attribute, or response to a food, using a continuum divided into successive values. Typically, the intervals on the **scale** are allocated sequential numbers, but they can be identified by symbols or be identified only at the ends of the continuum, and the assessor must interpolate between them. An example is a numeric **scale** for intensity of a stimulus, in which 0=absent, 1=very weak, 2=weak, 3=moderately strong, 4=strong, and 5=very strong. In this case, the **scale** is fully structured, i.e. each interval is labelled. A line **scale** consists of a line, say 10 cm long, drawn on the score sheet and labelled at the ends with the extremes of the scale, for example, absent and very strong, and perhaps also labelled in the middle. The assessor makes a mark on the line representing his/her perception of the intensity of the stimulus, and the distance of this mark from the origin is the measure of the intensity. (Lawless & Heymann, 1998; Meilgaard *et al*., 1999).
(3). Of fish, the small, thin, horny, protective modifications of the skin which often become easily detached during handling of some fish species, and in some species are removed (**descaling**) at a preliminary stage of processing such as **canning**.

Scombrotoxicosis, scombroid poisoning, scombroid fish poisoning, scombrotoxin poisoning An illness associated with the consumption of spoiled samples of some species of fish, particularly, but not exclusively, of scombroid fish, hence the name. World-wide, it is considered to be one of the most common causes of seafood poisoning. It is usually a mild illness with rapid onset of a variety of relatively non-specific symptoms - rashes on the face, nausea, vomiting and/or diarrhoea, headache, palpitations - though a particular patient might not show all these symptoms. Sometimes symptoms are confused with those of a ***Salmonella*** infection or food allergy. Fish and products that have been implicated in such **food poisoning** incidents have often, but not always, been associated with high concentrations of **histamine**. Because of this, and the similarity between the symptoms of **scombrotoxicosis** and those of histamine poisoning, the illness is, or was, often referred to as '**histamine poisoning**' or **histamine fish poisoning**'. Studies have demonstrated that the aetiology of the illness is not as simple as just ingestion of large amounts of histamine. It has been postulated that other toxic agents present in the fish may cause similar symptoms, or that there are other compounds formed in the spoiling fish which of themselves can cause the illness or interact with the histamine to potentiate the effects of histamine. Nevertheless, high histamine contents in fish are sufficiently associated with the illness for histamine content to be a indication of likely toxicosis, and it is used in **quality control** and mandatory inspection of species with a history of causing **scombrotoxicosis**. See **Histamine**. (Ahmed, 1991;FAO, 1985; Smith, 1992; Taylor, 1986; Lehane and Olley, 2000).

Scoring Making cuts through the skin of a fish to allow faster penetration of salt before smoking. See **Brining** and **Salting**.

Scum Undesirable accumulation of impurities as a film floating on the surface of brine.

Seal worm See **Cod worm**

Semi-preserves Fish products, especially those preserved in **salt** and **acetic acid**, that have a longer storage life than the untreated fish, typically 1 to 2 months in chilled storage.

Sensory analysis/evaluation Examination of the **organoleptic** properties of a product by means of the senses. '**Sensory**' and '**organoleptic**' should not be considered as synonyms. Use of 'sensoric' and 'sensorial'

instead of '**sensory**' is deprecated. The term 'subjective' should not be used describe **sensory** methods, as distinct from instrumental methods considered to be 'objective', because **sensory analysis** encompasses both objective and subjective methods. Objective methods are those in which experienced and trained assessors evaluate defined and described properties of products without any contribution of the personal likes and dislikes of the assessor; subjective methods are those using untrained assessors, as in market research, to give personal opinions of products. **Sensory analysis** is widely and extensively used in evaluating the properties of fish and fishery products in quality control and in research. (Lawless & Heymann, 1998; Meilgaard *et al*., 1999).

Sensory panel A group of persons brought together to participate in a **sensory evaluation** test. The preferred term for a member of a panel is '**assessor**' rather than 'judge', 'panellist', 'taster' or 'subject'. (ISO 5492).

Sequestrant See **Chelating agent**.

Series flow freezer See **Freezer**

Sharp freezing see **Freezing**

Shatterpack A block of frozen fillets or portions of fish interleaved by inserting sheets of paper or flexible film such as polyethylene between the fillets or portions in a pack (**interleaving**) before **freezing** so that the frozen pack can be divided readily while still frozen by giving it a light blow or knock.

Shelfing Stowage in the **fishroom** at sea of loose fish laid neatly in a single layer on a bed of ice on a shelf, preferably with ice also on top of the fish. See **Chilling**, **Icing**, **Boxing**, **Bulking**.

Shelf life The words are sometimes hyphenated. A concept in food science and technology applied to indicate the length of time a food product can be stored and remain acceptable, or not pose a health risk to the consumer. It stems from the wish or requirement to indicate the **storage lives** of products during retail display and distribution. **Shelf life** in this context need not be the same as **storage life**. For example, retail packs of frozen foods are labelled with **shelf lives** based on date of final manufacture and packing. This means that a product prepared from fish frozen just a few days previously will have the same indicated **shelf life** as one prepared from fish frozen years previously, and might have been stored under inappropriate conditions. There are other difficulties in trying to measure and indicate **shelf lives** or **storage lives** of fishery products. A major one is that there are no generally accepted criteria for defining end of **shelf life**. There are broadly three sets of criteria: those based on risk of harm to the consumer by growth of pathogenic bacteria or development of toxins; those based on wholesomeness, that is, fit for consumption; and those based on changes that render the product unacceptable to the consumer. The first two are explicit or implicit in food regulations; the last is the criterion, additional to the first two, adopted by retailers who wish to ensure consumers like, as distinct from not disliking, their products.

Shewart control chart See **Control chart**

Shigella A genus of rod-shaped bacteria in the family Enterobacteriaceae. They are responsible for the disease shigellosis, (bacillary dysentery). Fish from unpolluted waters do not harbour the bacteria, but can become carriers if caught or harvested from polluted waters, and products after harvesting can become contaminated in unsanitary surroundings. (Ahmed, 1991; FAO, 1994).

Shoulder bone See **Nape**

Shucking Removal of molluscan shellfish meat from the shell to yield the **shucked meat**.

Side See **Filleting**

Silage A liquefied product prepared by acid hydrolysis of fish or fish wastes. Used as a feed for animals. **Formic acid** or a mixture of formic and propionic acids are commonly used at 3-4% of the weight of fish or wastes. These **silages** do not need to be neutralised before use as feeds and are not corrosive to mild steel containers. Mineral acids, for example sulphuric acids, can also be used. They are much

cheaper than formic and propionic acids but are corrosive to mild steel and need neutralising before use as feeds. (Raa & Gildberg, 1982).

Silent cutter See **Surimi**

Single fillet See **Filleting**

Slacked fish Thawed fish as it may be termed in the USA. See **Thawing**.

Slice ice See **Icing**

Slow freezing see **Freezing**

Slurry ice See **Icing**

Slush ice See **Icing**

Small ice See **Icing**

Smoke (wood smoke) See **Smoking**, **Smoking kiln**, **Hardwood**, **Softwood**

Smoke density meter (smokemeter) See **Smoking kiln**

Smoke density See **Smoking kiln**

Smoked fish See **Smoking**

Smoke dip See Smoking

Smoke flavour See Smoking

Smoke generator (Automatic smoke generator) See Smoking kiln

Smokehouse See Smoking kiln

Smokemeter (smoke density meter) See Smoking kiln

Smoke producer (**firebox**) See **Smoking kiln**

Smoke solution See **Smoking**

Smoking The process of applying **wood smoke** to impart a smoky or **smoke flavour** to, and to partially dry a fish, or part of a fish such as a fillet, or shellfish meat, to produce a **smoked fish** product, and also to extend the shelf life of the product under some conditions. In many parts of the world, preservation is still the main purpose of smoking. Any **preservative** effect of the smoke itself is probably largely due to the presence of a range of phenolic compounds, nitrites and formaldehyde. The principal **preservative** effect is due to the lowering of the **water activity** as a consequence of the presence of salt and the degree of drying. There are three principal parts to the whole process, **salting** or **brining**, deposition of smoke (the term **smoking** is often simply used in this context, as well as for the entire process), and **drying**. The process can be carried out commercially on a large scale, on an artisanal scale, or domestically, but the further information given here refers to commercial production.
The fish are first prepared by **washing**, **heading** and/or **gutting** for some products, and **splitting**, or **filleting**, depending on the products. The prepared fish are either brined in a salt **brine**, that may contain a permitted **dye** or **colour** to achieve the desired yellow/orange/brown colour in some **smoked fish** products, or dry salted. Most fish are brined but **dry salting** is used for some salmon, herring and hot smoked products. After brining the fish may be left **dripping** or draining for several hours before smoking begins. For some products such as **sides** of salmon, some recipes require the fish to be dried for a period before smoking. The **smoked fish** is produced in a traditional or mechanical **smoking kiln**. In this stage the chemical components of **smoke** which impart the flavour, colour and some

preservative effects are deposited on the fish and the fish are dried to some degree. Alternatively, the **smoke flavour** can be added as a mixture of natural or synthetic flavorous chemicals. For example, so called **liquid smoke** is a solution or condensate of flavour components of wood smoke from which the **polycyclic aromatic hydrocarbons** have been removed or reduced. It is sometimes called a **smoke solution** and is used as a **smoke dip**, or as a spray. The spray is suitable for application in **electrostatic smoking** in which the droplets are electrically charged in a high voltage electric field and can be rapidly deposited on the fish or fillet. The **smoking time** is the length of time a product requires in the kiln to achieve the desirable flavour, colour and degree of drying, to which must be added the time required for brining, dripping, cooling (to avoid **sweating**) and so on to give the total processing time. The degree to which smoke constituents are taken up by the fish depends on the wetness of the surface and the concentration of the smoke constituents in the vapour.

There are two principal smoking processes. In **cold smoking**, the smoke temperature does not exceed 30°C and the fish are uncooked. Fish from temperate waters require a temperature just above 30°C for cooking to begin, especially when salt is present. Cold smoked products are intended to be cooked before consumption, but cold smoked salmon is a notable exception. In **hot smoking**, the smoke temperature is raised to at least 70°C at some stage during smoking, so that the fish are cooked during the process, and the product can be eaten without further cooking. In some products the temperature may be raised in stages as high as 95°C. Special attention needs to be given to food safety requirements for products that are intended to be eaten without further cooking. Traditionally, fish was subject to **heavy smoking** (a **heavy cure**) in which there was prolonged exposure to smoke to preserve it, often in combination with salting and prolonged drying. **Cold smoking** for a prolonged period until the fish is hard, mainly as a result of drying is known as **hard smoking** (a **hard cure**). Typically, the **salt content** is 10 to 15% and the fish loses 20 to 30% by weight during the process.

Traditional smoked products are still produced and remain important in some countries, but they tend to be too salty, too dry and have too strong a smoky flavour for the mass market in developed countries. In modern smoked products for these markets, salt and smoke are used primarily to flavour the products, and **mild** and **light smoking** processes are used. These milder processes contribute only a limited preservative effect resulting in only a small extension of shelf-life compared with that of the raw fish and in some cases should be regarded having much the same shelf life as unsmoked fish. If such a product, e.g. cold smoked salmon, is intended to be eaten without further cooking, the **salt concentration** in the water phase of the product and proper refrigeration of the product below 5°C along the whole chill chain from producer to consumer are critical factors for product safety. The minimum **salt concentration** in the water phase of the product should be 3.5% (weight by weight), as measured in the thickest part of the fillet. See **Smoking kiln**.

Smoking kiln There are basically two types of commercial kiln, the **traditional kiln**, sometimes called a **smokehouse**, a batch operation that depends on natural convection, and the **mechanical kiln** with forced convection and temperature control which can be designed as a batch or continuous operation. The **smoke** is usually generated by burning wood, **wood chips**, (**wood shavings**), or **sawdust** (or a combination of these) obtained from **hardwood** or **softwood** or some combination of these. In some regions of the world, wood is burned instead of sawdust, and this produces a hotter fire with less smoke so that the fish is charred rather than smoked. The wood or sawdust must be dry, not mouldy, and free from preservatives. **Wood smoke** is a mixture of aliphatic and aromatic vapours (which contribute the flavours), and condensed tarry droplets, and it has a very complex composition comprising among other components, acids, phenols, aldehydes and ketones, alcohols, and aliphatic and aromatic hydrocarbons. The droplets represent the visible component of the **smoke**, and the concentration of the visible smoke particles, the **smoke density** or thickness of the **smoke**, is used as an indication of the concentration of the invisible smoke vapours in a **kiln**. The composition and characteristics of the smoke depend on the type of wood, the water content of the wood, the temperature to which it is heated to produce the smoke, and the manner in which it is heated. Any **preservative** effect of the smoke is probably largely due to the presence of a range of phenolic compounds, formaldehyde and acids.

In a **traditional kiln**, the movement of smoke and warm air depends entirely on natural draught, usually by means of a chimney, as in the **chimney kiln**, where the smoke rises by convection through fish or fillets hung above a fire of smouldering sawdust. The results are very variable and there is very little element of control. It is also known as a **tall kiln** or **vertical smokehouse**. Various designs have been built such as the **London kiln** or smaller **north kiln**, both used mainly for **cold smoking**, or those designed mainly for **hot smoking**. In a **mechanical kiln**, the smoke is moved over the fish vertically or horizontally by means of a fan. The temperature of the **smoke** can be controlled much more closely because the **smoke** is generated outside the kiln in a separate **smoke producer**, designs of which vary.

The **smoke** can be distributed much more evenly over the fish so that the fish are all smoked and dried consistently at the same rate. The **Torry kiln**, originally developed in the 1930s at Torry Research Station, is a batch kiln that can be built to a range of capacities from 100 kg to 1200 kg/4 hours. The temperature, **humidity** and speed of a constant horizontal stream of **smoke** can be controlled. It is one of a number of widely used successful designs suitable for both **cold** and **hot** smoking. The **smoke producer** (**firebox**) is the apparatus in which the wood is burnt to produce the **smoke**. It can range from a simple hearth with dampers controlling the supply of air, to an **automatic smoke producer** (**smoke generator**) in which the wood is burned continuously and the combustion temperature is controlled. Typically, sawdust is fed continuously from a hopper onto an electrically heated plate or **firebed**, but **smoke** can also be produced by blowing hot air or super-heated steam through a bed of sawdust, or combustion can be achieved by application of friction to a block of wood. The **smoke density** in the kiln can be measured using a **smoke density meter** or **smokemeter** usually designed to measure the degree of light scattered by the smoke. In modern kilns the production and intensity of the smoke, and the temperature and humidity are computer controlled, the smoke is recirculated, weight loss can be monitored, emissions are controlled, and the consumption of sawdust or wood shavings is about 10% of consumption in the traditional smokehouse. See **Smoking**.

Smoking time See **Smoking**

Snap freezing see **Freezing**

Snow ice See **Icing**

Sodium chloride See **Salt**

Sodium Hexa-metaphosphate See **Hexa-metaphosphate**.

Softwood Wood from coniferous trees such as pine; the sawdust produces a resinous smoke when burned. It is less suitable for imparting a smoky flavour to fish than that from hardwood, but the smoke from softwoods generally colours the fish more quickly. Wood treated with preservatives must not be used for smoking. See **smoking** and **smoking kiln**.

Sorbic acid An organic acid found naturally in some fruits. It is a permitted food **additive** as a **preservative** and is used as the sodium or potassium salt for this purpose in some fishery products, especially dried products.

Sorting Separating into defined categories of species, sex, length, weight, either at sea or onshore, or **grading** to sort into defined categories of some aspect of quality such as size or **freshness**. If used, the terms **sorting** and **grading** should be qualified to indicate the type of **sorting** or **grading**, e.g. species sorting or size grading, to avoid misinterpretation. **Sorting** is often used in the context of defining the **out-grade** to be discarded because, the weight, or the degree of spoilage, freezer-burn, parasitic infestation, colour, blemishes, damage, taint, belly-burst, or some other quality aspect is unacceptable. Sorting into various types of categories may be carried out by eye, by smelling or tasting. It may be carried out mechanically for size by means of inclined roller graders of various designs, or by automatically making a physical measurement such as weighing, or by scanning, for example, by computer aided vision, laser or infrared, all of which can be linked electronically to control sorting flaps on a conveyor system. See **Grading**

Sous vide Usually refers to composite foods intended for catering outlets, e.g. fish or shellfish with vegetables and sauce, sealed in a vacuum pack and pasteurised. These products are often given an extended **shelf life** at chilled temperatures of 2°C or less. See **Heat-treated** (**Heat-processing**)

SPC (**Standard plate count**) See **Total viable count** (**TVC**)

Species identification Determination of the species of a fish or part of a fish to establish its **authenticity**. Identification might be required to support enforcement of regulations, for example restrictions on fishing for a particular species or enforcement of regulations relating to naming of fish offered for sale, or in testing for compliance with specifications. If the whole fish, or substantial parts of it, are available then identification is usually a matter of taxonomy. Identification becomes difficult when

parts without clear distinguishing features, for example fillets, are only available. Chemical methods can be used to determine species. Frequently used procedures are **electrophoresis** or iso-electric focussing of proteins. These procedures are not always successful with heat processed fish as the extreme heat processing renders the proteins insoluble in the simple aqueous solution used for raw fish. Stronger solvents can be used to solubilise the proteins but, in this case, there is less differentiation among species. More recently, methods based on identification and comparison of DNA fragments have been developed. (Bossier, 1999; Mackie, 1997). See **Electrophoresis**.

Specification Written description of the particular requirements of a product that are important to the buyer, seller, or regulatory body or agency (see **standard**). See **Code of practice**, **Quality**, **Quality assurance**, **Quality control**.

Specific heat capacity The quantity of heat required to raise the temperature of the unit weight of a substance by one unit.

Spent fish See **Lean fish**

Spiral freezer See **Freezer**

Splitting Production of a **split** fish by cutting (by hand or by machine) partly through a **gutted** fish along its length from throat to **vent** or **tail** and laying it open to expose some or all of the backbone prior to smoking; sometimes the head is removed. **Splitting** may be done in different ways depending on the product, for example, along the belly as for a finnan (headless, brined, cold smoked, haddock) or along the back as for a **kipper** (brined, cold smoked herring). See **Gutting**, **Klippfisk**.

Spoilage The process of rendering a stored food unfit for consumption, particularly by the action of microorganisms such as bacteria, moulds, and yeasts. The spoilage process in fish and shellfish produces unpleasant **odours** and **flavours** (referred to as **off-flavours/odours**) and adversely affects **appearance** and **texture**. The rate of spoilage is much reduced by chilling, but even under well chilled conditions, the first signs of spoilage are detected in white fish, for example, after about 7 days and the fish is unfit for consumption after about 15 days. Apart from temperature, **pH** affects the rate. Low **pH** fish such as tunas spoil more slowly than typical demersal fish. Small, fatty, pelagic fish such as sprat and herring spoil more rapidly than typical demersal fish. Other, non-microbiological, reactions, such as the hydrolysis and oxidation of oils in fatty fish, contribute to the **off-flavours** of spoiled fish and can be included in the general concept of **spoilage**. Reactions that produce **off-flavours**, but are not associated with microbiological spoilage, for example production of **off-flavours** in **frozen** stored fish (**cold storage flavour**), should not be referred to as **spoilage**. Also see **Freshness**.

Spray freezer See **Freezer**

Spray thawing See **Thawing**

Springer A **can** of fish with a bulging end that when pushed back in causes the other end to bulge. It must be rejected. The effect can be due to insufficient vacuum in the can, microbiological **spoilage** activity occurring post-processing, or internal corrosion in the can. See **Canning**.

Squeezing belt See **Minced fish**

Stack See **Klippfisk**, **Salting**

Stack burn In **canning**, an undesirable effect of over-processing caused by the stacking together of processed cans while still hot.

Standard plate count (**SPC**) See **Total viable count** (**TVC**)

Standard A **specification** that is issued by a regulatory body, standards agency, or an international agency, such as **Codex Alimentarius**, closely linked with governments.

Staphylococcus aureus Species of **food poisoning** bacteria. Widely distributed on human skin, hair and in the nose and throat of healthy people, and the cause of boils and a variety of skin and wound infections. It can contaminate and grow on foods under favourable conditions and some strains may produce heat stable enterotoxins that cause abdominal pain, sickness and diarrhoea in 6 to 24 hours after consumption. It is used as an indicator of general hygiene and good food handling practices where less than 100 organisms/g in a sample is considered satisfactory, but greater than 1000/g may indicate the potential presence of enterotoxins and the risk of food poisoning. Enterotoxins from prior contamination may still be present after heat processing despite the absence of viable *S. aureus cells*.

Steak A slice of varying thickness cut from across a fish at right angles to, and including a piece of, the backbone.

Sterile Free from all living micro-organisms. Also see **Canning** and **Commercial sterility**

Sterilisation Process of making an environment or a product **sterile**, or nearly so, usually by the use of a chemical **sterilizer**, a chemical agent that kills living micro-organisms (disinfectant, sanitizer, sterilising agent) or by physical treatment such as heating (see **Canning**) or irradiation.

Stinkers See **Bilgy fish**. Also refers to fish, especially cod (*Gadus morhua*), that have an intrinsic unpleasant odour and flavour, often described as **weedy**, as a result of feeding on planktonic molluscs called pteropods. Also see **Blackberry odour** and **Dimethylsulphide**.

Stockfish A traditional dried cod (*Gadus morhua*) product in Iceland and Norway. Traditionally, it is made by hanging up headless cod in the open air, often for 6 weeks or more, until dry and hard, and the water content has fallen to about 15%, so that moulds do not grow. Larger fish are usually split and may be hung in two pieces. Some other species such as ling (*Molva molva*) and blue ling (*Molva dypterygia*) may also be treated in this way. The fish can now be dried much more rapidly in a dryer which changes the characteristics of the product compared with the traditional product. See **Drying** and **Water activity**.

Storage life See **Shelf life**.

Straight-cut See **Heading**

Struvite Crystals of calcium or magnesium ammonium phosphate occasionally found in **canned fish** and **shellfish**, especially in salmon, tuna, mackerel and crustacean meat, and sometimes in **chilled** or **frozen**, **smoked fish**. The crystals are transparent, have a glassy consistency and are harmless, but can be mistaken for shards of broken glass. Occurrence of **struvite** is linked to the presence of magnesium chloride, a common component of unrefined **salt**, in the **brine** used in processing, and to high, *post-mortem* **pH** in the meat. Common preventive measures include addition of either sodium hexametaphosphate or citric acid both of which sequester free magnesium and calcium ions, or lowering the pH of the product to avoid precipitation of the crystals.

Superchilling (**Partial freezing**) Reducing the temperature of fish to just below -1.5°C and maintaining this temperature under closely controlled conditions to extend the storage life of the fish for a few days. The most beneficial temperature for white fish is -2°C but the fish becomes partially frozen which causes practical difficulties and should be avoided if the intention is to chill the fish and keep it chilled. Domestic refrigerators in some countries have been designed with a compartment intended to maintain a temperature in the region of -3°C to extend the **shelf-life** of chilled products. The system is claimed to have benefits for the extension of **shelf life** of some fatty fish. Sometimes referred to as **deep-chilling**.

Surimi A washed, refined, and stabilised **fish mince**, a process originally developed in Japan to provide an intermediate and relatively stable frozen material suitable for the subsequent production of traditional **kamaboko** products. Preparation of **surimi** is a means of intensifying the gelling properties of fish protein and of preserving these properties during **frozen storage**. A typical process is outlined below. The **minced fish** from a **bone separator** is washed successively in water and dilute **salt** solution (0.15%) to wash out the soluble proteins, enzymes, blood, pigments, other solubles, and fat, and to concentrate the myofibrillar proteins. It is strained or refined in a **refiner/strainer** to remove unwanted

fragments of skin and connective tissue, bones and dark muscle. Next, while keeping the temperature low, it is quickly ground finely in **a silent cutter** or **ribbon blender**, and uniformly mixed with sucrose (4%), sorbitol (4%) and **polyphosphate** (0.3%), or in other combinations. These act as **cryoprotectants**, protecting the functional gelling properties of the myofibrillar proteins during **frozen storage** in blocks at -30°C. **Salt** may also be added (2.5%) at this stage. **Fish gels** that have the textural characteristics termed **ashi**, and are light or white in colour, provide the basis for the traditional **kamaboko** products can be produced from the thawed **surimi** material by adding **salt** and heating at about 90°C. In this process, **white fish** such as Alaska pollack (*Theragra chalcogramma*) produce a cohesive, elastic texture (**ashi**) that is highly prized in Japanese **kamaboko** products. Consistent production of these gels and careful control of the functional properties has been used in Japan and other countries as the basis for development of a variety of novel and successful fabricated, shellfish analogue products, simulating, for example, crab, prawn, scallop and lobster meat, and these are known generically in Japan as **neriseihin**. A variety of **white fish** species may be used to successfully produce **surimi** but, overall, the yield is low (up to about 20% from whole fish) and the process consumes large volumes of water. **Surimi** from **fatty fish** is much darker, less stable, has inferior texture, and the yield is even lower.

Sweating Moisture exuding from the interior to the surface of a fish while cooling after **smoking**. If it is packed while still hot, a moist product is produced that encourages the growth of moulds.

Tail The abdomen or hinder part of the body of crustaceans containing the edible tail meat.

Taint An **odour** or **flavour** foreign to a product. The distinguishing feature of a taint, as distinct from **off-flavour/odour**, is that the chemical responsible for the taint is not produced in the product, but comes from its surroundings. **Taints** often have an unpleasant character, but that is not a necessary condition for taint. In the case of fish in the aquatic environment, taints are acquired from the ambient water. Examples are the **earthy/muddy taints** in freshwater fish and oily taints in fish exposed to petroleum or petroleum products. Products can be tainted by strong smelling chemicals such as phenolic **disinfectants** in the ambient air. See **off-flavour/odour**. (Howgate, 1999; ISO 5492).

Tall kiln See **Smoking kiln**

Tar The unwanted layer of tarry constituents of **wood smoke** that forms on the inner surfaces of a **kiln** during **smoking** by the continual deposition of droplets.

Taste See **Flavour/odour**

Taste panel The preferred term is **sensory panel**. (ISO 5492)

Tempering Softening by raising the temperature of frozen fish without thawing, especially regular, cuboid fillet (**laminated blocks**) or mince blocks, to a level typically between -10°C and -15°C suitable for the efficient sawing, cutting, slicing or dividing of these blocks into smaller blocks, slabs, portions, fingers or sticks. Fish readily conduct heat at temperatures below -10°C, and only about 40 MJ of heat are required to soften one tonne of fish.

Tempura batter See **Coating**

Tetrodotoxin Tetrodotoxin is a potent, water soluble, neurotoxin associated with fish of the family Tetraodontidae, hence the name. Fish in this family are called pufferfish, or go by the Japanese name fugu. There are marked differences in toxicity among species, some species are virtually non-toxic. The toxin is present in various organs of the fish, including the muscle tissues, though concentrations are much higher in the gonads, liver, intestines and skin, than in the muscle. The illness induced by the toxin is tetrodotoxicosis (**puffer fish poisoning**). The first symptom of intoxication is a slight numbness of the lips and tongue, appearing between 20 minutes to three hours after eating toxic material, followed by paraesthesia, (sensation of prickling and tingling in the skin), in the face and extremities. In more severe cases, there is increasing paralysis throughout the body, including respiratory centres. The disease is associated with a 50% mortality. The toxin is not confined to tetraodonts; other species of vertebrate and invertebrate fishery products have been reported to have the toxin - parrotfish, the blue-ringed octopus, starfish, angelfish, and xanthid crabs. The toxin is not now

thought to be produced by the animals since recent studies have shown that several common marine bacterial species, including strains of the family Vibrionaceae, *Pseudomonas* sp., and *Photobacterium phosphoreum* can produce **tetrodotoxin** or a derivative of it. This remains a matter of debate, and the relationship between the bacteria and the poisonous fish, and the mechanism of transfer of the toxin are not understood. (Smith, 1992).

Texture All the rheological, geometrical, and surface attributes of a product perceptible by the senses. The main sense involved in texture evaluation is an as yet poorly defined sense perceived by pressure sensors in the mouth and skin, and by position sensors in the muscles and joints, the kinaesthetic sense. (ISO 5492).

Texture profile An experimental procedure used in the **sensory evaluation** of foods. The assessor evaluates components of the texture of a product using descriptors from a prepared list of terms. The assessor also rates the perceived intensity of each **texture** attribute identified. Most **scales** for rating **texture** attributes are bipolar, that is, the end-points of the **scale** are described by antonyms, for example, tough/tender, firm/soft. The results are combined over members of a panel of **assessors**, and the resulting assemblage of terms and intensities forms the **texture profile**. See **Flavour profile**. (Lawless & Heymann, 1998; Meilgaard *et al*., 1999).

Thaw drip See **Thawing** and **Drip**

Thawing Melting the ice contained within frozen fish and also called **defrosting**. This occurs completely when the temperature throughout the fish is higher than -1°C. The time required to just melt all the ice in frozen fish is the **thawing time**. The heat required to thaw white fish from the temperature of cold storage of -30°C to a uniform temperature of -1°C is about 300 kJ/kg; fish with a fat content of 15% would only require about 240 kJ/kg. Fish usually lose weight on thawing. The **thaw drip** or **drip loss** may be as high as 5% depending on the degree of deterioration which occurred during the previous period of frozen storage.
Methods of **thawing** (batch or continuous) fall into two groups; heat can be conducted into the flesh from the surface so that **thawing** is limited by the rate of conduction, or heat can be generated uniformly throughout the flesh. The first group includes exposure to still air, which is very slow and not practicable commercially, or to moving warm, moist air **(air blast thawing**), or to condensing water vapour (**vacuum thawing**), or to **water thawing** by immersion (**immersion thawing**), by spray (**spray thawing**), or by some combination of immersion and spray. **Spray thawing** is difficult to control. The second group depends on controlled absorption of energy at mains (**electrical resistance thawing**), radio (**dielectric thawing**) or microwave (**microwave thawing**) frequencies, and all result in much faster rates of thawing, but require careful control. Overheating must be avoided in all applications and the fish temperature should not exceed 18°C. **Air blast thawing** can be achieved in practice by using air at 20°C, saturated with water vapour to improve heat transfer and prevent surface drying, moving uniformly over the fish at an **air speed** or **air velocity** of 6 to 8 m/s. Typically, under these conditions, the **thawing time** for a 50 kg block of gutted cod, 100 mm thick, is about 4 to 5 hours -30°C. **Water thawing** is acceptable for whole fish, and is typically by immersion in water at a temperature not exceeding 18°C, flowing at about 1 m/min. White fish lose their gloss and the skin becomes bleached, whilst herring will lose most of the remaining **scales**. The **thawing time** for a 100 mm thick block of whole fish is about 5 hours from -30°C under these conditions. The basis of **vacuum thawing** is the heat released when water vapour condenses on the fish in an evacuated chamber. Water in the evacuated chamber is heated to 18°C to produce water vapour. The water cools in contact with the frozen fish and eventually reaches a temperature below which the water begins to condense as a liquid. Since most of the air is evacuated, the rate of condensation becomes so high that it can provide heat as fast as it can be conducted to the inside of the fish, and the water vapour can easily enter the small spaces between fish in the frozen block and between blocks. The heat released at the freezing point amounts to 2400 kJ/kg of water that condenses, and approximately 125 kg of water will condense for each tonne of white fish thawed. Thawing rates are comparable with air blast and water thawing. A problem with this method is that gases normally present in the tissues are released during thawing and can spoil the appearance of soft textured fish. Sometimes the skin can be ruptured on the dorsal surfaces of white fish or on the belly walls of fatty fish when the fat content is high. In **dielectric thawing** the frozen fish is placed between two parallel electric plates carrying a high alternating voltage, high frequency, electric field, typically 5 kV and 80 MHz respectively. Under ideal conditions, with blocks of uniform thickness, composition and temperature, heat is produced rapidly

throughout the thickness of the blocks without contact with the plates, and thawing is rapid. In practice, large blocks of whole large fish are immersed in water to create a more homogeneous electrical environment, generate heat more evenly and avoid local overheating, and the fish are conveyed through a series of separate thawing units. The **thawing time** for a 100 mm thick block of white fish is about 1 hour. Smaller blocks of small fish or product are not immersed and can be thawed in the packaging. **Electrical resistance thawing** uses the heat generated internally by the resistance of frozen fish to an electrical current passed through it. The electrical frequency causes oscillation of dipoles in the water as the direction of the electrical field changes, producing frictional energy and heating the fish. The application is a hybrid type because frozen fish is a poor conductor of electricity until its temperature rises above -10°C, at which point electrical resistance continues to decrease with increasing temperature. Fish is first immersed in cold water and warms rapidly to a temperature, still frozen, at which a high enough current is conducted to generate enough heat to complete the thawing. Alternating current at mains frequency, but low voltage, is applied to flat blocks of frozen fish in electrical contact between larger flat metal plates. The system is suitable for blocks up to about 50 mm thick and the total **thawing time** ranges from 30 to 50 min. **Microwave** power used for **thawing** can be at least ten times as fast as **dielectric thawing** but the fish is much more prone to overheating. When fish are subjected to microwaves, generated typically at about 3000 MHz, the radiation is absorbed by the flesh. Heat is generated, being greatest immediately below the surface, and progressively less as the radiation penetrates deeper into the flesh. The warmer the flesh becomes, the more readily it absorbs the energy, and the less the radiation is able to penetrate it, hence the frozen fish warms unevenly and is more likely to be overheated. Microwave heating is more suitable for cooking from frozen, especially recipe dishes and ready prepared meals, for thawing smaller items, and for **tempering**. Thawed fish may be referred to as **slacked fish** in the USA.

Thawing time See **Thawing**

Thermal arrest See **Freezing**

Thermal centre The point in a product that has the highest temperature after **chilling** or **freezing**, or the lowest temperature after **thawing**, or has the lowest temperature in the contents of a container during heat processing (**cold spot**). It is not necessarily the geometric centre of the product. See **Freezing** and **Canning**.

Thermal conductivity The quantity of heat conducted through unit area and thickness of a material in unit time, under the influence of unit temperature difference.

Thermal process See **Heat-treated** (**Heat-processing**) and **Canning**

Thermal process lethality See **Canning**

Thermophilic Describes micro-organisms termed thermophiles or thermophilic bacteria that grow best at elevated temperatures in the range 55 to 75°C. ***Bacillus stearothermophilus*** is an extremely heat resistant **thermophilic** spore forming bacteria which has been found to be responsible for the **flat-sour spoilage** of **canned** foods. See **Canning**.

Thiobarbituric acid (TBA) value A measure of the amount of reaction products of **oxidation** of **lipids**. It is based on measurement of the amount of **malondialdehyde**, a major oxidation product.

Torry freezer See **Freezer**

Torry kiln See **Smoking kiln**

Total viable count (TVC) Also called **Aerobic plate count**, **Standard plate count (SPC)** and other tems. A frequently performed **microbiological count**. It is the number of bacteria growing on a non-specific solid bacteriological growth medium under the specified conditions. A sample of product is blended in an appropriate solution and aliquots of the suspension, after dilution as necessary, are applied to the medium. The inoculated plate is incubated in air and, after a specified time, the number of visible colonies are counted. The results are typically expressed as colony forming units (c.f.u.)/g. An important variable in the experimental procedure is the temperature of incubation. An incubation

temperature around 35ºC favours **mesophiles**, and provides a general index of sanitary or **hygienic** conditions of the handling and processing of the product. Lower temperatures, around 20ºC, favour **psychrophiles** and are more indicative of **spoilage** bacteria on chilled fish. (FAO, 1994).

Total Volatile Bases (TVB) Equivalent terms are **Total Volatile Basic Nitrogen** (**TVBN**) and **Total Volatile Nitrogen** (**TVN**). The amount of basic, nitrogen-containing chemicals distilled from an alkalised extract or suspension of a fishery product. The bases, **amines**, in the distillate are determined by titration with standard acid. The amines all have one basic nitrogen atom in the molecule and **TVB** is expressed on a nitrogen basis, typically mg nitrogen/100g of sample. The main component of **TVB** from very fresh fish is **ammonia** and, as fish spoils, increasing amounts of **trimethylamine** (**TMA**) are present. Small amounts of **dimethylamine** (DMA) are often present in **TVB** from spoiled fish. During distillation, nitrogen-containing chemicals in the sample are decomposed by the hot alkaline conditions to **ammonia**, so that the **TVB** content is greater than the sum of the bases present in the sample. Elasmobranchs have **urea** in their muscle tissues which decomposes to **ammonia** under the typical conditions for **TVB** measurement. The amount of **ammonia** from this decomposition depends on distillation conditions, especially temperature and degree of alkalisation, and **TVB** varies with details of the experimental procedure used to determine it. The lowest, and probably true, value is given by distillation at room temperature from a mildly alkalised sample. There are two main variants of the analytical procedure: distillation at boiling point of an aqueous suspension of a sample made alkaline with magnesium oxide; distillation at boiling point of a protein-free extract of the sample with strong alkali. The latter gives a higher result, by around 4 mgN/100g, than the former. **TVB** is used as a measure of **freshness** because it increases as fish spoils. But, it does not increase substantially until the fish spoil, typically around 7/8 days in ice for vertebrate fish, and is not suitable for discriminating among freshnesses of fresh fish. The main contribution to changes in **TVB** during spoilage is the increasing presence of **TMA**. **TVB** content is used by some regulatory agencies to confirm fish as being unfit for human consumption. (Botta, 1995).

Toughness A term referring to an attribute of **texture**, an aspect of **quality**, the attribute of high resistance to deformation and disintegration.

Toxin A natural substance produced by an organism capable of causing harm to another organism, including man. The meaning is sometimes broadened to include any chemical causing harm to an organism, but it would be better to use 'poison' to refer to the broader class with **toxin** as a subset. In nature, toxins are taken into animals by ingestion. The word is frequently compounded to show the origin of the toxin. For example phytotoxin for a toxin present in plants; phycotoxin is frequently used for a toxin present in algae; mycotoxins for a toxin present in fungi (moulds). The term biotoxin has the same meaning as toxin as defined above, but it is often used in writings on food poisoning to emphasis the difference from poisons of non-biological origin. Sometimes the compound word indicates the target of the toxin, for example neurotoxins attack the nervous system and hepatotoxins affect liver function. Many of the toxins found in fish and shellfish are neurotoxins and some are hepatotoxins. Others are compounded to reflect the initial source of identification of the toxin, such as pectenotoxin or brevetoxin. There is some confusion in the nomenclature in this area.

Traditional kiln See **Smoking kiln**

Transshipping See **Klondyking**

Trematodes Trematodes or **flukes** are members of the zoological Class Trematoda of the Phylum Platyhelminthes. They are small, but not microscopic, flattened, (hence the trivial name, **flatworms**), and generally leaf-shaped animals. Within the Class there are two Orders: *Monogenea*, and *Digenea*. The latter includes members that are parasitic in freshwater fish and crustacean shellfish and can be transmitted to man causing disease. Examples of genera of *Digenea* posing hazards to humans include, but are not confined to, ***Clonorchis***, ***Opisthorcis***, ***Paragonimus***, ***Metagonimus*** and ***Nanophyetus***. Digenetic trematodes have animals, including man, as definitive hosts, and two intermediate hosts. The first is an aquatic snail; the second is a freshwater vertebrate fish or a freshwater crustacean shellfish, depending on genus. (Deardorff, & Overstreet, 1991; Howgate, 1998; WHO, 1995; WHO, 1999).

Triglycerides (**Triacyglycerols**) See **Fats**.

Trimethylamine oxide (TMAO) A compound of formula $(CH_3)_3NO$ of wide occurrence in animals and in bacteria. It is present in the flesh of marine species of fish and crustacean shellfish, but generally not in the muscle of freshwater fish. It is metabolised by some species of spoilage bacteria of fish, and is split enzymatically into formaldehyde and **dimethylamine** in the muscle of some species of fish, including during frozen storage. (Hebard *et al*., 1982).

Trimethylamine (TMA) An **amine** of formula $(CH_3)_3N$. Formed in the muscle tissue of stored unfrozen fish by the bacterial metabolism of **trimethylamine oxide (TMAO)**. It has a strong ammoniacal smell and the ammoniacal smell of spoiled fish is likely to be due to **TMA** rather than ammonia. The muscle tissue of living fish contains only traces of **TMA**, typically less than 1mg TNA nitrogen/100 g. Not all species in the bacterial flora of fish when caught metabolise **TMAO** and **TMA** formation is slow until the psychrophiles, which include important **TMA-**producing species, begin to increase in numbers. **TMA** content then increases approximately exponentially with storage time, reflecting the increase in **bacterial count**. **TMA** content, like **TVB**, can be used as an index of **spoilage**, but it is more precise than **TVB** because there is not the problem of dependence of results on the experimental procedure. **TMA** is most frequently determined by a colorimetric procedure, (Dyer's method), or by gas liquid chromatography (GLC). A variety of other procedures based on different principles from those just listed have been described, but have not achieved popularity or application. The procedures for measurement of **TMA** are not fast enough or simple enough for use in routine **quality control**. (Botta, 1995).

Tripolyphosphate See **Polyphosphates**.

Truck freezer See **Freezer**

Tube ice See **Icing**

Tunnel freezer See **Freezer**

TVB See **Total Volatile Bases**

TVC See **Total viable count**

Ungutted See **Gutting, Belly burst**

Urea A chemical of formula $(CH_2)_2CO$. It is the end-point of nitrogen metabolism in animals and some fishes. It is a feature of elasmobranchs, (sharks, dogfishes, rays, skates), that they accumulate **urea** in their tissues. **Urea** has a **bitter taste** and contributes to the characteristic flavour of this group of fish. It is degraded to **ammonia** by enzymes in muscle tissue and by **spoilage** organisms of fish, leading to the very strong, pungent, odour of spoiling elasmobranchs.

V-cutting The **pin bones** in the anterior portion of the **fillet** can be removed in many commercially important species of **roundfish** by making a cut through the skinned fillet along both sides of the line of **pin bones** from the neck end towards the tail of the **fillet**, such that both cuts meet just behind the position of the last pin bone. Thus, an acute angled, v-shaped cut is made, the V-cut, which contains the **pin bones** and can be removed to leave a V-cut fillet. The proportion of fillet removed by **V-cutting** varies according to the species and degree of skill and experience exercised in cutting. It ranges from 4 to 15% for **roundfish** such as cod, haddock and whiting but usually lies in the range 8 to 12 % when cut by hand. Some **heading** machines are described as **V-cut** heading machines which refers to the type of angled head cut directly behind the **collar bone** as opposed to **heading** machines that either make a so-called round-cut or a straight-cut to remove the head. See **filleting**, **gutting**, and **heading and gutting**.

Vacuum dried salt **Salt** made by evaporating **brine** under a vacuum.

Vacuum drying See **Drying**

Vacuum thawing See **Thawing**

Vapour pressure See **Relative humidity**

Vent Anal opening at the rear of the belly cavity of a fish, through which are discharged wastes from the intestine and kidney, and also eggs or sperm.

Vertical plate freezer See **Freezer**

Vertical smokehouse See **Smoking kiln**

Viscera See **Gutting**

Void See **Laminated block**

Washing This term may refer to a number of aspects of fish handling and processing. Cleaning of the gut cavity of **gutted** fish by hand with jets of water or by means of a mechanical washer prior to **boxing**. The **bleeding** and **washing** steps may be combined in a mechanical system. It may refer to the cleaning of iced fish or thawed fish in water to remove mucous, slime or loose scales prior to **filleting**, or to preparation for some other process such as **smoking** or **canning**, or to the cleaning of shellfish prior to **shucking**. It may refer to the removal of excess **salt** from **dry salted** fish prior to **smoking**. It may refer to the process of treating fish mince or **minced fish** with successive water and brine washes to remove soluble proteins, pigments and lipids during the production of **surimi**.

Water activity (a_w) The microbial and chemical stability of dry food and feed products depends on the $\mathbf{a_w}$ of the product. It is a measure of the availability of water in the product, to react chemically, or to support the growth and metabolism of microorganisms, such as **bacteria** and moulds, during **spoilage**. It is expressed as the ratio of the water vapour pressure of the product, or solution, to that of pure water at the same temperature. The a_w of pure water is 1.0. The a_w of a saturated solution of **sodium chloride** (**salt**) at 25°C is 0.765. Reduction of the $\mathbf{a_w}$ in a product to low levels, i.e. less than 0.75, by direct removal of water by **drying**, or by the addition of solutes such as **salt** or sugar, or by some combination of these factors, can restrict the growth of many microorganisms. Most bacteria cannot grow below $\mathbf{a_w}$ 0.9, but ***Staphylococcus aureus*** can grow down to approximately $\mathbf{a_w}$ 0.85, red obligate **halophiles** (require high salt concentrations in the region of 15 to 20% to grow) will grow at 0.75, and some yeasts and moulds can grow as low as $\mathbf{a_w}$ 0.6 - 0.7. Dried foods with an $\mathbf{a_w}$ less than 0.6 are microbiologically stable, such that the **shelf life** is not limited by microbial **spoilage**, provided that they remain dry. The microbial and chemical stability of dried fish products during processing and storage is dependent on their $\mathbf{a_w}$. In freshly caught fish, $\mathbf{a_w}$ is above 0.95, and can be decreased by **drying** and **salting** processes to reduce the rate of microbial growth, as well as the range of microorganisms that can grow. The **water activity** of a dried fish product can be calculated from the **water content** and **salt content** (expressed on a fat-free, dry matter basis).

Water content The amount of water in a product. It is commonly determined by the loss in weight on heating a sample of the product at 105ºC for 18-24 hours.

Water thawing See **Thawing**

Weed See **Deveining**

Weedy odour See **Dimethylsulphide**, **Blackberry odour**, **Stinkers**.

Wet fish A term sometimes used to describe unfrozen fish, especially **chilled** fish, that are also called, sometimes incorrectly, **fresh** fish.

Wet salting See **Salting**

Wet stack See **Salting**, **Klippfisk**

White fish Fish species in which the main reserves of fat are in the liver, e.g. cod (*Gadus morhua*). Fish with less than 2% fat in the flesh. Also referred to as **lean fish** which has other meanings. **White fish**, as the description of fish content in a product, means that the product may contain material from more

than one white fish species. Not to be confused with the local or trivial name, whitefish, for the Japanese icefish (*Salangichthys microdon*, also called whitebait). See **Fatty fish, Lean fish**.

White spot Blemish on dried salted white fish, caused by formation of crystals of disodium hydrogen phosphate, usually on stale raw material stored in very dry conditions. Not to be confused with infections of the organism *Ichthyophonus hoferi* in the condition known as **greasy haddock**.

Whole fish Ungutted fish. See **Gutting**, **Roundfish** (**rounders**).

Wing See **Heading and gutting**

Wood chips (wood shavings) Fragments of wood larger than **sawdust** that produce more flames and heat, and less **smoke** than **sawdust** when burned. See **smoking** and **smoking kiln**.

Wood smoke (smoke) See **Smoking**, **Smoking kiln**, **Hardwood**, **Softwood**

Wood shavings See **Wood chips**

Wooden box See **Boxing**.

Worms See **Cod worm**, ***Anisakis***, **Nematodes**

Yield Generally, the amount of product that is obtained from the raw material. Of most interest in fish technology is the **yield** of edible material. Typical **yields** of edible meat from some major groups of fish are:

vertebrate fish, as skinless fillets	40%
shrimp and prawn	45%
crab	30%
bivalve shellfish	15%
cephalopod	70%.

Within these groups, yields vary with species, and within species with size, season, and **condition**.

ω(omega)-3 fatty acids, ω(omega)-6 fatty acids An alternative naming system for **polyunsaturated fatty acids (PUFAs)**. The **ω** carbon atom in the molecule is that of the terminal methyl group corresponding to **n** in the other system so ω-3, for example, refers to the position of the first carbon atom counting from the terminal carbon, the third in this case, attached to a double bond.

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