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Freshness Of Fish And Its Measurement

Fish is a highly perishable commodity. When newly caught it has pleasant, sweet flavours that are highly acceptable. On storage these flavours are progressively lost and though the fish is acceptable, it is not of such high quality. Further storage produces off flavours, and ultimately these become so strong that the fish is unfit to eat.

Fish is generally stored and transported in ice, and, under these conditions species from arctic or temperate waters will reach the unfit state within about two weeks. Tropical fish can be held somewhat longer. Spoilage is much faster if the fish is not held at chill temperatures. It is therefore important for anyone concerned with quality of fish to be able to measure its freshness i.e. the amount of deterioration that has occurred since it was caught.

Traditionally, freshness has been assessed by sensory methods; using the human senses of sight, smell and touch. This approach gives an immediate appraisal of quality without damage to the fish.

However, there are some difficulties. Trained and experienced staff is required, and this training takes a long time. It is not easy to make sensory assessment quantitative. The changes occurring during spoilage can be described and codified, but individuals may interpret these descriptions somewhat differently. Though a single judge may be consistent within himself, different judges will vary among themselves.

This makes it difficult to establish standards that can be applied in different locations, and by different assessors.

There is therefore a need for objective methods for measuring freshness that do not depend on the subjective opinion of human judges. Several chemical procedures are in use for this purpose, but all suffer from common disadvantages in respect to quality control within the industrial environment, in that they are somewhat slow to carry out, whereas quality controllers and inspectors usually require an immediate answer. The analysis requires laboratory facilities and appropriately qualified staff, a feature which renders the methods unsuitable for field work, and expensive for factory use. The methods are destructive and the damaged fish samples are no longer fit for processing.

Generally, a quality controller or inspector needs to evaluate the freshness of a batch of fish rather than one individual sample. An appropriate number of fish are taken, the fish evaluated separately and the average of the batch calculated. The recording and calculation required, though simple, are inconvenient to carry out at the market or in the factory.

There is therefore, a requirement for a rapid and objective method for measuring fish freshness in a wide range of conditions. The method should be accessible to untrained staff and non-destructive in use. Preferably it should also allow batch grading with a minimum of computation and record keeping.

The Fish Freshness Meter, or Torrymeter, has been developed to meet these requirements.

Freshness Meter Benefits

The Fish Freshness Meter, when used with organoleptic charts, eliminates the uncertainty, delay and cost previously incurred by sending fish samples to a test laboratory. It can be used out of the box on known, calibrated fish species, and after a simple calibration procedure for new species.

The following sections of the manual explain fully how to use the meter and organoleptic charts. Before these, it will be useful to have an introduction to their underlying concepts.

For known species – one for which an organoleptic chart exists – the procedure is simple. Take a meter reading from a sample of your required species; the result, measured on the Torry Freshness Scale, should be between 16 for fresh and 1 for spoiled. Then refer to the relevant organoleptic chart for an interpretation of the meter reading and its implication for the freshness of your sample.

For example, if you wish to sample cod which is boxed between catch and port, refer to the first chart in 'Organoleptic charts'. This chart shows that a meter reading of 16 represents a fish of less than 2 days old. A reading of 8 would indicate that the fish was 10 days old and a reading of below 3 would indicate that the fish was more than 18 days old and spoiled.

If the species is not known and has no organoleptic chart, you can perform a custom calibration exercise in which you generate a chart for future reference. To do this, take a set of readings for the fish as it decays from fresh to spoiled. This may give a reasonable set of readings from somewhere near 16 (fresh) to 3 or below when spoiled. If this is in fact the case, the readings can be used to write into an organoleptic chart which becomes the reference for the new species.

Alternatively however you may find that the range of readings as the fish decays from fresh to putrid is too narrow for useful interpretation. For example you may see an initial reading of 12 when fresh and 8 when spoiled. The answer is to use the full internal range of the meter, which has much more resolution available than the scales available with the TORRY-1 (0.1 to 18.5) or TORRY-STD (1 to 18) scales. The internal range is accessed using the RESEARCH-1 calibration, which offers a range of 0.1 to above 99.9.

By taking a second set of readings using this higher resolution you will be able to obtain a set of meaningfully differentiated readings over the narrow range of the 12 – 8 example above. Having obtained a reference dataset of such readings over the period from fresh to putrid you can:

a. Simply continue using this dataset as a reference for future measurements of the same species, or
b. Load the data into a spreadsheet for further analysis or reference, or
c. Generate an Analysis Dataset of equal daily decrements from 18 to 1, and use this within the Data Management System to scale the Reference Dataset readings. The scaled output dataset becomes the new custom calibration for the new species; it can be stored in the meter and entered into a new Organoleptic Chart.

You can refer to the Freshness Meter Technical Manual, on the USB FLASH DRIVE and on the Distell website, for more information on custom calibrations.

General Description

This latest model of the Fish Freshness Meter is compact, robust, fully portable and suitable for any normal application within fish processing industry markets, processing factories or quality control laboratories. It provides rapid measurements and is simple to use.

The freshness of the fish is indicated on the LCD display.

The meter can be set to measure from 1 - 16 fish. The menu driven software will sum the readings of all the samples and then display their average value. The meter is most accurate in this mode.

Generally the measurements can be taken without disturbing the fish in their containers, and the testing does not damage or mark the samples in any way.

Principle Of Operation

The original research leading to the development of the Fish Freshness Meter was carried out at Torry Research Station, in Aberdeen, Scotland.

It was found that certain dielectric properties of the fish skin and muscle alter in a systematic way during spoilage, as tissue components degrade. These alterations, occurring at microscopic level, are strongly associated with the gross changes in appearance, odour, texture, and flavour which take place during spoilage and which are normally used to judge freshness. Hence, determination of the appropriate dielectric properties gives a measurement of the freshness of the fish.

The base of the instrument (sensing head) has two pairs of concentrically arranged electrodes. This sensing head is applied directly on to the skin of the fish. An alternating current is passed through the fish, between the outer pairs of electrodes and the resulting voltage sensed by the inner pair. The phase angle between the current and voltage is measured and converted electronically to allow digital display on a convenient scale in the range 0 - 18. The phase angle and hence the meter reading decreases with spoilage. The current passed through the fish is approximately 1 milliamp and so cannot harm the operator or affect the fish.

Between the measuring electrodes are two auxiliary electrodes. These electrodes, in conjunction with one of the carbon electrodes, sense whether there is proper contact with the fish. The fish sensing device prevents readings being taken under inappropriate conditions e.g. in air, or in ice. Since the phase angle depends on temperature as well as freshness, the reading displayed by the instrument must be corrected to the value it would show at a reference temperature of 0°C.

The meter is powered by rechargeable batteries within the instrument. They have sufficient capacity to allow a full working day's operation.

Technical Data

These is a separate Technical Section later in this manual.

Step-by-Step Guide

The Freshness Meter kit

Your Freshness Meter kit comprises the following items:

Meter Unit

Power Supply / charger

USB Data Cable

USB Flash Drive

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Carry Case

Please take good care of the meter. It is a measurement instrument and should be handled carefully. The meter should be cleaned and stored in its case after use.

Meter unit

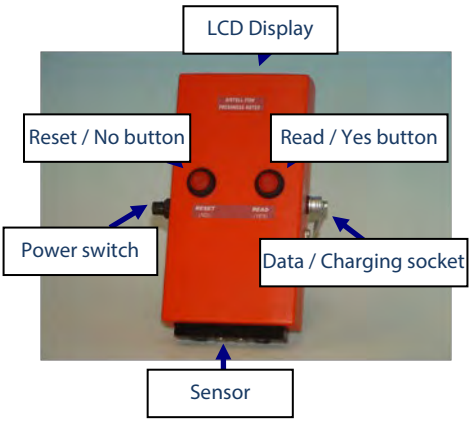
Data / power socket

The 7-way socket on the side of the meter serves three functions:

Data download socket, for transferring data to PC, using cable supplied.

Allows the meter to run on external power

Used for charging internal batteries



Sensor

The sensor has two outer carbon electrodes for measuring freshness, and two inner metal electrodes for sensing contact with the skin of the fish.

It is a good idea to wipe the sensor clean between readings, since it is easy for fish scales to stick to the sensor and affect readings.

Read button (Yes)

Press and hold this button to take a reading;

Press to answer 'Yes' to any Yes / No question on the display.

Reset button (No)

Press to reset the measurement routine, or to abort an incomplete series of readings;

Press to answer 'No' to any Yes / No question on the display.

Data cable

Always use the data cable supplied for downloading to computer. Connect the 7-way plug to outlet on meter and the other end directly into a USB port on your computer.

Digital Manual – USB Stick

This contains your user manuals, Data Management System, calibration charts, and other useful information.

User Manual

A hard copy of the user manual and the calibration certificate is included.

Carry Case

The Freshness Meter kit is supplied in a robust carry case, and comes complete with two keys for security of your Freshness Meter.

Power Supply / Charger

Only the unit supplied with your kit should be used to charge the battery pack, or power the meter. This is connected to the 7-way outlet on the meter. The charger supply unit simply plugs into the mains socket, accepting input mains voltage from 110v–240v AC, 50–60 Hz. The charger unit comes complete with various plug configurations for use around the world.

A red LED will illuminate when charger / power supply is switched on. The battery pack should be fully charged after a period of 12 hours. When charging is complete, first disconnect the charger from the mains and then from the meter.

The power supply / charger can also be used to power the meter during use while also charging the internal batteries at a reduced rate.

Charging The Meter

Notes on charging the Meter:

Insert power unit connector plug carefully into meter socket (to insert, turn plug gently until the plug slides into the connector.

Meter should be charged for a full 12 hours before use if possible.

Always ensure that meter is switched “OFF” before charging.

When charging is complete, first disconnect the power unit from the mains and then from the meter.

Always fit dust / moisture cap in place before commencing work, especially in wet environments.

Note: Use only this Distell power unit for battery charging or meter power. Do not use excessive force when plugging the power unit into the meter socket.

Getting Started

Verify that battery has been charged.

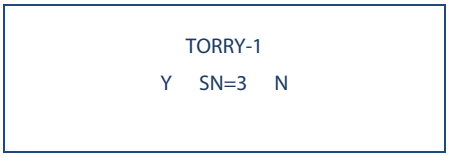
Switch on

Switch on the Meter and allow the meter to cycle through its start up procedure.

Part of the start up procedure is to show how many readings are currently stored in the meter. You may wish to download and erase any stored readings before taking new measurements. You can find out about the download procedure in the 'Data Management System' section.

After around 15 seconds the meter is ready for use. The display will show the last calibration setting used, and will look something like the example below:

Calibration Setting



Yes Number of samples used to calculate average No

Measuring product samples

Have a copy of the organoleptic charts at hand. For best accuracy always follow the measurement recommendations in this manual.

Before starting we recommend you carry out some checks:

1. Check that you have set the correct number of samples, from 1 to 16, from the Samples menu.
2. Check that you have selected the correct calibration setting on the meter for the fish being sampled.
3. Check to ensure that you have prepared or have been supplied with an organoleptic chart suitable for this fish species.
4. Select the fish samples at random from the batch. Where you are taking fish samples from a varied batch, the samples should be grouped according to size (length / weight).
5. Check that temperature of the fish to be measured is between 0 and 10°C, with no ice crystals present in the samples.

The measurement procedure is outlined as follows:

1. Ensure that the sensor is placed firmly against the skin of the fish, thus ensuring that there are no air pockets between the sensor and the sample to be measured. Press the **Read / Yes** button; the Meter will confirm contact with the fish, take the measurement, display and store the value.
2. If you see 'No Contact' displayed on the meter then check that the sensor is making good contact with the skin of the fish. The meter will not take any readings until it detects good skin contact.
3. For best results be consistent. Always place the sensor on the same part of each fish. This will ensure that you achieve optimum, comparable results. It is normal to experience variability in the individual readings when taken at different parts of the fish. Note also that different parts of the

fish will spoil at different rates, depending upon the level of bacteriological activity present within the fish.

4. One set of readings should be taken from each fish, at the recommended measurement sites. The results will be stored in the Freshness Meter for later downloading.
5. Place the base of the meter firmly on the fish so that it lies flat against the surface and parallel to the lateral line at a thick, fleshy part of the fish. The best position is at the shoulder area within the first third of the fish, in the region of the lateral line, as shown in the illustration below. Avoid the head and belly cavity regions.

6. If this is the first reading after the meter has been in a warm place, hold the probe head against the fish for 10-20 seconds, to allow the sensor to cool down before pressing the **Read / Yes** button.
7. To measure individual fish, set the Freshness Meter to read 3 samples (see the 'Menu structure' section for details), place the meter at the recommended measurement site, and take measurements three times. The individual values and the average value will be stored in the meter for downloading. When the average value is shown on the display press **Read / Yes** to take more readings on a different fish or press **Reset / No** to finish.
8. Avoid pressing the READ button when the meter is not in contact with a fish. If there is a thick layer of slime on the probe head it may conduct enough current to act as if the electrodes were in contact with a fish and a measurement will be made.
9. Switch the meter off after use to retain the charge in the battery.

Normally three readings are recommended. We have found that this gives the best balance between accuracy and speed. You can change the number of readings that the meter will take before averaging by using the 'Samples' menu option. See the 'Menu structure' section for more details.

The Freshness Meter can store up to 1000 sets of readings. These can be downloaded to a PC running the Data Management System. See the 'Data Management System' section for more information on how to do this. There is also an option to download the data in real time, i.e. as the readings are taken, and this is covered in the same section.

Comparing the meter with laboratory analysis

If you wish to compare the results achieved using the Freshness Meter with a laboratory procedure, it is important that the entire fish carcass sample is packaged and sent to the laboratory for the analysis.

The sample should be stored in a sealed polythene bag immediately after measurement and the temperature of the sample should be maintained as close to 0°C as possible. This will ensure that spoilage of the sample is reduced as far as possible.

Important: Do not allow the sample to freeze.

The whole carcass of the fish / fillet should be received at the laboratory properly packed and sealed, and the current 'age from death' of the sample should be ascertained using standard laboratory methods, e.g. TVBN, etc.

If the results from the Laboratory do not compare favourably with your meter check the meter's use as follows:

Is the operator proficient in the use of the Fish Freshness Meter?

Is the fish species the same as that quoted on your Organoleptic Chart?

Check the product for species identification, measurement technique, size and preparation.

Check the laboratory procedure as follows:

Verify the analytical method being used

Check that the sample preparation was OK

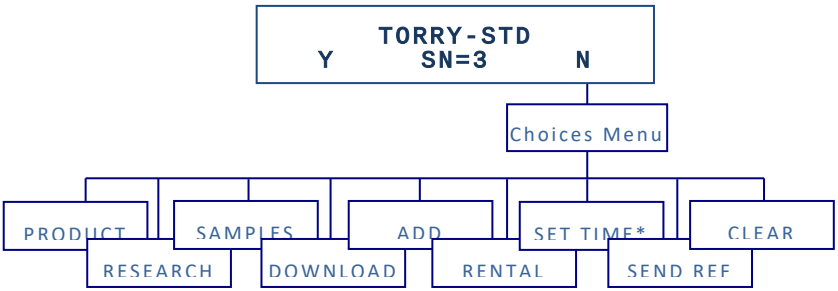
This is just a short check list on how to use and compare the Freshness Meter with other methods. Remember that the primary purpose in using the Freshness Meter is to screen a lot of product for uniformity, specification and shelf life, and to identify fish that has been frozen or irradiated.

During the measurement process, finite accuracy is not the objective. The object is to try and ensure that the bulk of the day's raw materials and processed production meets with your specifications time after time.

If, after these checks there is still a significant difference, please contact Distell for advice and help. Note that the Distell website has a comprehensive Frequently Asked Questions section as well as technical information on the Freshness Meter.

Menu Structure

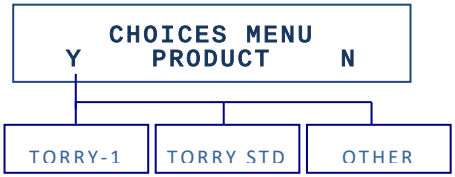
When the standard measurement display is shown (see the example at the start of this chapter) you can access the menu by pressing the **Reset / No** button. The Choices menu screen will appear in the order shown below. There are six options. Cycle through the options by pressing **Reset / No** until the correct one is displayed then press **Read / Yes**.



* Only one of the SET TIME and RENTAL KEY options will be available.

Product Menu

In the Product menu you can choose which of the product calibration settings you wish to use. Simply choose the calibration that corresponds with the type of measurement you wish to use.



Research Menu

In the Research menu you can choose which of the research calibration settings you wish to use. The Fatmeter is normally supplied with the RESEARCH-1 setting but additional calibrations can be added to the research block via the Custom Calibration process. Full details are available in our Technical Guide, which is available on the USB FLASH DRIVE and from our website.

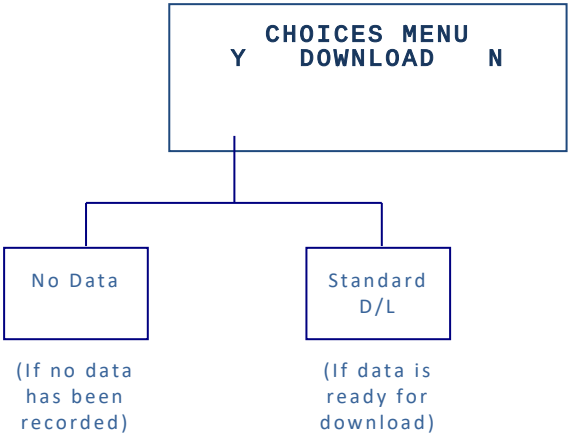
Samples Menu

For greatest accuracy you should use eight samples per fish and measure eight fish from a batch. For single fish we recommend that the Freshness Meter be set up for three samples per fish. In both cases, all the measurements should be taken at the same site on the fish. You can choose between 1 and 16 samples here.

Note: if you choose 16 samples then the individual sample values will not be reported as they are taken, i.e. the sampling is done 'blind'. These individual readings are stored in the meter and can be seen when downloaded to the Data Management System.

Download Menu

The Download menu allows you to send any stored sample data to a connected PC running the Data Management System. The DMS is documented later in this guide, and the download procedure is covered there.



Add Product Option

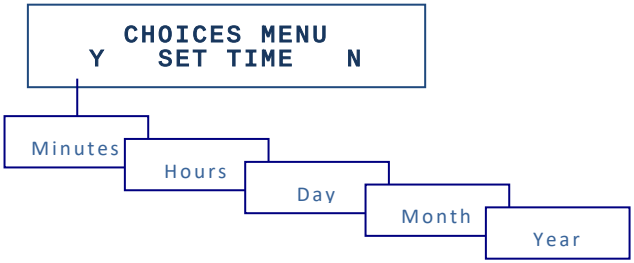
Using this menu provides the ability to programme the meter with additional calibrations. This facility is especially useful for those who wish to refine existing meter calibrations or create a new calibration setting based on their own data.

Full instructions on how to use this facility are in the Technical Manual, available on the USB FLASH DRIVE and from the Distell website.

Date & Time menu

You should check the date and time when you first receive the meter, and update it if necessary. Each sample that is recorded by the meter has a date and time stamp, so it is recommended that the date and time be kept accurate. This will then ensure that all downloads reflect the correct date and time.

Note that if a meter is configured as a rental meter then this option will not be available.



Rental Key Option

If your meter has been supplied as part of a rental agreement then the Rental Key menu option will be available. This allows you to enter a sequence of eight numbers and letters that is specific to your meter, and is used to change your rental settings, e.g. change the rental expiry date.

You can read more about rental keys at http://www.distell.com/downloads/rentalkey.pdf.

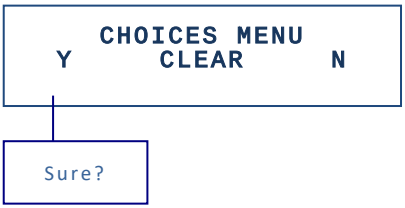
Send Ref option

This option is used by the Custom Calibration process to copy the meter's built-in RESEARCH-1 calibration setting to the Data Management System. This data is used as a reference to construct a custom calibration.

You can read more about this in the Technical Manual available on the USB DRIVE or on the Distell website.

Clear Option

This menu option allows the user to clear any stored readings from the meter. Normally this is not required because stored readings can be cleared after being downloaded to the Data Management System. Some users, however, may use the meter purely for instant measurements without ever downloading the samples and, in time, the Fatmeter's storage capacity will fill up and 'MEMORY FULL' messages will be displayed. In these circumstances this menu option can be used to erase the samples and avoid the 'MEMORY FULL' message being displayed.



Usage recommendations

Using the meter in quality control

Sampling

The Fish Freshness Meter was designed with the needs of the quality controller in mind. The term 'quality controller' is meant to include officials responsible for public health inspection or enforcement of mandatory regulations concerning quality, as well as persons concerned with quality control in industry and commerce. In a typical situation, a controller is required to test batches of fish that are being inspected, sold or processed as a unit, and for this a suitable sample must be taken. The meter simplifies this process of assessing a batch by sampling.

If the freshness of individual fish within a batch is measured with the meter, it will be found to vary. This fish-to-fish variation in meter readings is caused by two factors:-

a. Variation in intrinsic freshness among individual fish.
b. Variation of meter readings among fish of the same freshness.

Both are expressions of the variability of biological organisms. A batch of fish caught at the same time and handled and stored identically will spoil at slightly different rates because of variations in chemical constitution and bacterial activity. Hence the individual fish in the batch will have a range of freshness; a range that will tend to increase as spoilage increases.

The meter readings themselves are not direct measures of freshness, as defined in sensory terms, but are strongly associated with it. The relationship between meter readings and freshness as measured by a sensory panel will once again be different for each individual fish. For this reason it is not recommended that the meter be used to assess the freshness of single fish, except within rather wide limits.

These deviations from average behaviour tend to cancel out when the means of samples from batches are taken, and the bigger the sample the better the correlation between the mean meter reading and freshness score. It follows from sampling theory that the number of fish which ought to be sampled from a batch depends mainly on the desired precision of the mean score. It also follows that, provided the batch is large enough, the required sample size does not depend on the size of the batch. From observations made, it has been decided to use a sample size of eight fish as the basis for the averaging in the Fish Freshness Meter.

In most marketing and distribution systems the fish are held in containers with a capacity of 50Kg. Several containers constitute a batch. In this situation fish from as many containers as possible should be sampled i.e. one from each container if the batch has eight or more, four from each container if that is all there is in the batch. If the controller or inspector wants greater confidence in the batch average, more than one set of eight fish can be sampled, and a grand average of the results calculated.

Note that the precision of an averaged result increases only as the square root of the sample size. An average of 64 readings is only twice as precise as an average of 8 readings.

Freshness Meter Performance

The relationship between meter readings and other measures of freshness

There are many ways of expressing the freshness of fish. Perhaps the simplest for fish held in ice is to quote the storage time. However, as is well known, the initial quality of many species of fish varies with the seasons of the year, due to such factors as the spawning cycle and the availability of food. These factors also affect the rate of spoilage, so that the time in ice is not necessarily a good measure of freshness unless related to the time of the year. It has been found that a better way of expressing freshness is to construct a system of numerical scales based upon methods of objective sensory assessment by a trained taste panel.

Such a system is better because it is directly related to eating quality rather than depending on knowledge of the storage conditions.

Often the fish is allocated to one of a few quality grades based on definitions in sensory terms. An example of this is the European Economic Community's system of grading fish for marketing purposes. An extreme form of this type is the public health inspector's grading into fit and unfit. A quality controller may not even consciously put a score or a grade to a batch, but must accept or reject it for the purpose in mind.

In practice the quality controller in industry adopts the most convenient system for his purpose, but an official inspector will have to use whatever is laid down in the regulations. It is quite possible to define grades, boundaries or acceptance/rejection ranges of freshness for various outlets, etc, in terms of meter readings and indeed this is a good way of using the instrument. However, until the user is familiar with the instrument, it is best to employ it in parallel with the accustomed method of assessing freshness. After some experience, the relationship between the quality levels the user is familiar with and the meter readings can be established. Nevertheless, the meter can be used by an unskilled operator after very little instruction.

As a guide to the values that can be expected from some species of interest to European Fish Processors, average readings for different levels of freshness are shown in the set of organoleptic charts in the 'Organoleptic charts' section. These results were obtained by Torry Research Station at their laboratories in Aberdeen and Hull, and at various fishing ports in the UK. The sensory scores are based on the scales used at Torry Research Station, and have been described in their publications.

These scales were interpreted as follows:

Perfectly fresh fish is given a score of 10.

Good quality fish has a score of 6 or more.

Below a score of 4, the fish are considered unfit to eat.

These freshness scores are only a rough guide. Users are strongly advised to obtain equivalent levels from scores given by their own trained panel, as the scores may be based upon different criteria, or obtained under different conditions, from those obtained by Torry Research Station and Distell.

For comparison, the approximate number of days of storage in ice which would cause the fish to reach a given freshness score is also included in the charts. An explanation of the different columns of meter readings is given in the next section.

The examples given are typical demersal fish. The situation with fish of high and variable fat content is rather more complex, and the relationships between the meter readings and sensory scores are not always well defined. However, extensive work carried out by the staff of Torry Research Station with herring has established that the manner in which meter readings vary with time of storage in ice is very dependent on:

a. The fat content of the fish.
b. Whether or not it is iced immediately after catching.
c. The extent to which it is subjected to handling.

The organoleptic charts show the approximate age in ice corresponding to given meter readings for boxed herring of various fat contents. The age-in-ice is valid only for fish which has been boxed and iced immediately after catching. Delayed icing always gives rise to lower meter readings during subsequent storage in ice compared with those shown in the chart.

The extent of the effect varies with fat content and temperature during storage before icing. For example, lean fish held for 8 hours at a temperature of about 5°C before icing will generally show meter readings about one unit lower than the appropriate organoleptic chart would suggest. With fatty fish the effect can

be up to twice as great for the same time and temperature before icing. There is evidence to show that the higher initial temperatures can easily double this effect.

Mackerel generally behave in much the same way as do herring, although detailed information is not at present available. The organoleptic charts for mackerel (pages 42 and 43) give some idea of readings to be expected from carefully handled fish, boxed and iced.

Although less is known of the relationship between objective sensory scores and meter readings than for white fish, it is believed that meter readings give a fair indication of the intrinsic quality of unhandled, boxed fatty fish, irrespective of fat content.

The charts on pages 24 to 58 show relationships between the Fish Freshness Meter readings and time of storage in ice for a few species of African fish. The data has been supplied by the Tropical Products Institute, London.

Effects of Handling and Processing

The Fish Freshness Meter measures certain properties of fish muscle and skin that change in a systematic way during storage in the wet state. Any other process that affects the structure of the muscle at the cellular level will also affect the measurements, almost invariably to lower them. Handling is an important factor.

A common method of handling fish in Europe is to store it, mixed with ice, in bulk aboard the vessel, then unload it onto the quayside and sort the fish into containers. The pressure it is subjected to in the hold, the handling during discharge, and the sorting process tend to lower the meter readings when compared with fish that have been stowed carefully in boxes with ice and kept undisturbed until measured. The difference is indicated in the charts in the 'Organoleptic charts' section.

The meter can also be used to grade fillets. For skin-on fillets make the measurements on the skin side in the usual way.

The meter measures properties of both skin and muscle, but it can still be used with skin-off fillets. In this case the meter should be applied to the bone side of the fillet. The readings though, are much lower than for whole fish or skin-on fillets of equivalent freshness. Also discrimination in fish material with a freshness score below 6 is not possible. Typical values for cod are shown in the charts beginning on page 28.

The quality of herring and mackerel is most sensitive to handling, and in each case this is reflected by the readings obtained with the meter. Even careful handling of the fish can lower the instrument readings by 1 or 2 units. Normal commercial handling reduces the readings still further.

Effects of Freezing and Brining

Freezing has a drastic effect on the cellular constituents of muscle. It is not possible to determine the original freshness of thawed fish since meter readings are invariably in the range of 0 – 3, whatever the quality before freezing. In fact, this property can be used in many cases to determine whether fish has been frozen at some time in its history. If the sample, judging by odour, appearance and flavour appears to be fresh i.e. should have a high meter score, but in fact gives a low reading then there are grounds for suspecting it has been frozen at some time. Once again judgment should not be based on one fish only; several fish should be examined.

Brining also lowers the reading though not quite as much as freezing. It is therefore not possible to check the freshness of brined fish.

Meter care and service

Cleaning and General Care

The Freshness Meter is a sealed unit and is waterproofed prior to leaving the factory. However, we do not recommend that the unit be immersed in water or any other fluid. Anyone tampering with the unit, opening the seals, etc., will immediately invalidate the warranty.

The meter is encased in impact resistant ABS plastic, with the sensing probes made from stainless steel and carbon materials. It may be cleaned with a damp cloth, using a mild solution of soap or detergent in water. Be aware that some household cleaners may contain chemicals which could seriously damage the plastic housing. Avoid the use of any petroleum based solvent cleaners. Do not let slime dry out on the electrode surfaces. Do not attempt to clean the electrode surfaces with abrasives.

The unit should be charged regularly and the meter retained within its case when not in use, for safekeeping.

The Freshness Meter is a precision instrument. Ensure that the unit is stored securely in transit. Do not drop or otherwise misuse the equipment, as this may invalidate the warranty.

Before calling for service

If you have reason to believe that a fault has occurred, please first of all check the following:

Is the unit switched on?

Has the battery pack been charged?

If no obvious fault is apparent please telephone our Help Desk for advice and to report the fault.

Warranty and service

Your Torrymeter is fully warranted against manufacturing defect for a period of 12 months. The warranty and terms & conditions are explained in our Technical Manual, available on the USB FLASH DRIVE or from the Distell website.

If you need to return the unit for repair, please contact your supplier for advice on how to do so. The meter should be carefully packed, together with an explanatory note as to the nature of the fault.

Should you have difficulty in returning your Freshness Meter to your supplier for servicing, you can always contact Distell directly using the information in the 'Contact details' section. Please quote the date of purchase and give a full description of the fault.

Data Management System

Installation

Requirements

The Data Management System, referred to as the 'DMS', requires a PC running Windows XP or later and a free USB socket for data downloads.

Installing the DMS

This section tells you how to install the program on your system and how to run the program.

It is best to close all programs before installing the software. You should have at least 5 Mb of hard disk space available for the installation.

Insert the USB Drive in the computer;

Find the 'Installation files' folder on the USB DRIVE then open the 'Data Management Software (DMS)' folder;

Run the *DMSInstaller.exe* file and follow the prompts to complete the installation

Running the DMS

Click the Windows Start button on your desktop, select programs, select Distell then locate the DMS icon from the files listed there.

You can use the program straight away after installation. The program enables you to download, print, save, and export data, quickly and efficiently. The DMS also allows you to create and upload your own custom calibrations to the Freshness Meter (see the Technical Manual on the USB Flash Drive and on the Distell website). All program functions are accessed using the menu and toolbar options. There is a comprehensive on-line help facility, which is available by clicking on the Help menu option.

Historical Data Download

This function enables you to download readings that are stored in the Freshness Meter.

The data includes the date and time of the sample, the calibration setting that was used, the number and values of the individual samples taken, and the average value of the samples.

To illustrate the procedure, we'll assume that you have taken some sample readings with the Freshness Meter and are ready to download them to your PC.

Step 1: Connecting the Meter

Connect the meter to a USB port on your PC, using the data cable supplied with the meter, then turn the meter on. When the cable is connected the USB driver software installed on the PC will create two 'virtual serial ports'. Normally these are COM3 and COM4, but this may change if you have other USB virtual serial devices installed. Your computer will normally reserve COM1 and COM2 for built-in hardware, or for legacy purposes

Step 2: Configure the DMS

Start the DMS then use the Preferences option under the Edit menu to select the COM port to use. If the USB driver created COM3 and COM4 then you would choose COM4 here. In general you should always select the virtual COM port with the higher number. If you see an error message when you select the COM port then ensure that the meter is connected properly and turned on. If it is, try selecting a different COM port.

Once you have connected the meter and selected the correct communication port, select Download Historical Data from the Download menu. The DMS will now monitor the COM port for incoming data from the meter.

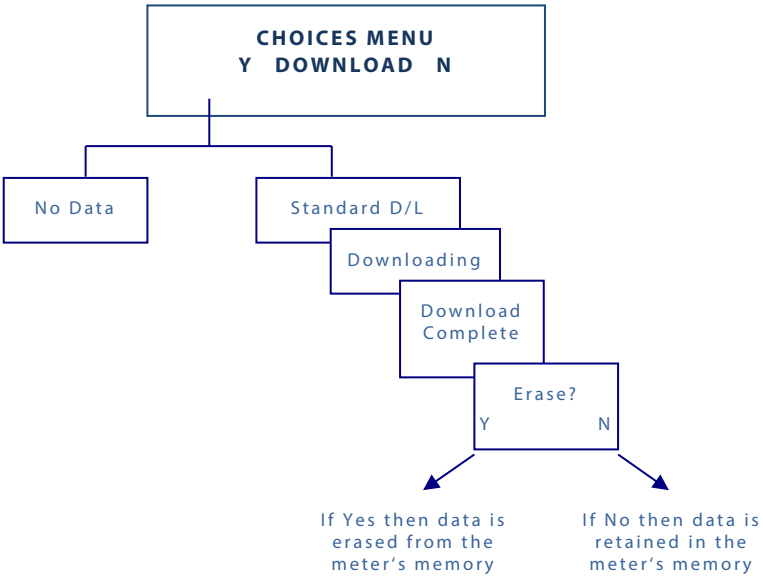
Step 3: Initiate the download from the meter

Once the DMS is ready and waiting for data, the meter needs to be told to begin the download.

Find the 'Download' option in the choices menu (see 'Menu structure'). At the 'Standard D/L' option, press the **Read / Yes** button then look for the data arriving at the DMS.

If no data is seen at the DMS then you may have selected the wrong COM port. Go back to step 2 and try an alternative port.

Once the data has been safely downloaded then you can, if you wish, erase the data from the meter. You can, alternatively, allow data to build up in the meter up to the maximum 1000 readings. If you wish to clear the data from the meter at a later stage then you can go through the download process but without connecting the meter to the PC, then reply Yes to the 'Erase?' question.



When the data has been successfully downloaded, it will appear in the DMS in a spreadsheet / grid form. With the data in the DMS you can now:

Print the data

Add extra columns of information

Save the data in native form as an .FMD file.

Export the data as a Comma Separated Value (.CSV) file for exporting into other applications such as Excel, Access, etc.

Real Time Data Download

You can use this function to download data in real time, sample by sample, each time that an average reading is created by the meter. The real time data will appear on screen line by line as you use the meter.

The purpose of the real time facility is to allow the user to see sample data instantaneously, as the readings are taken. Each time that an average reading is generated by the meter, it downloads the sample data via the USB communications port.

There is no specific process in the meter to download data in real time; the samples are automatically sent to the PC as they are taken.

Enabling real-time data download

Connect the meter to the PC and start the DMS, as described in steps 1 and 2 of 'Historical Data Download', above, then select 'Real-time download' from the Download menu.

Data will now appear in the DMS once the average reading has been recorded in the meter.

Annotating the data

The DMS presents the data in a grid with one row for each set of samples. You can add extra columns to the grid using the 'Add a new column' option of the Edit menu, and use that column to add notes about any given sample. Extra columns can also be deleted using the 'Delete column' option of the Edit menu.

DMS data files

Like most applications, the DMS can save data to a file on disk and load it back in again. Data is stored in a proprietary format in files with a .FMD extension. The Open and Save options under the File menu are used to load and save these data files.

Printing data

The DMS can print a report of the data for audit purposes. The Print option is under the File menu.

Exporting data

The DMS was never intended to be an analysis tool. Instead, you can export the data to a Comma Separated Value file (.CSV) for use within a spreadsheet or database. To export the data, select Save As... under the File menu, then select 'CSV files (*.CSV)' in the 'Save as type' option.

Data Management software Help

The DMS program provides an On-Line Help Facility. This can be accessed at any time when using the software program.

Advanced topics

The DMS has the capability to create custom calibrations and to upload those calibrations to the meter. These are areas that are not expected to be of interest to most users, so they are not documented here. You can, however, read more about them in our Technical Manual, which is available on the USB FLASH DRIVE or can be downloaded from the Distell website.

Organoleptic charts

The following pages show organoleptic charts for a range of commercial fish species. This is not meant to be an exhaustive list, and users of the Fish Freshness Meter are encouraged to create their own organoleptic charts to cover the different species and handling / storage methods that are of interest.

This user manual is included on the USB Flash Drive that is part of the Freshness Meter Kit.

You may wish to print out individual charts for your convenience.

Blue Fish (pomatomus saltatrix), normal handling

Species: **Blue Fish** Pomatomus saltatrix			Applies to: **Normal handling**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for Bluefish.						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	14 - 13	1 - 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	13 - 12	3 - 4	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	11 - 10	5 - 6	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	9	7 - 9	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	8	10 - 12	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	7	13 - 14	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	6	15 - 16	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	5	17 - 18	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	4 - 3	18 - 20	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	3 - 2	21 - 22	Not graded	
Putrid, Sulphides	Inedible	0	2 - 1	> 22	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Blue whiting, boxed

Species: **Blue whiting** Micromesistius poutassou			Applies to: **Boxed fish**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for blue whiting landed at European ports						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	15	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	14	2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	12	3	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	10	5	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	8	7	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	6	9	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	4	~ 11	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	< 3	> 12	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	< 3	> 12	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 3	> 12	Not graded	
Putrid, sulphides	Inedible	0	< 3	> 12	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Blue whiting, normal handling

Species: **Blue whiting** Micromesistius poutassou				Applies to: **Normal handling**		
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for blue whiting landed at European ports						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	15	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	14	< 2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	12	2	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	10	3	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	8	4	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	6	6	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	4	7	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	< 3	9	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	< 3	~ 10	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 3	~ 11	Not graded	
Putrid, sulphides	Inedible	0	< 3	> 12	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Chisawasawa, normal handling

Species: **Chisawasawa** Lethrinops praeorbitalis	Applies to: **Normal handling**					
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for chisawasawa.						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	14	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	13	2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	12	4	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	11	7	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	10	9	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	9	12	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	8	14	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	7	~ 17	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	6	~ 19	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	5	~ 21	Not graded	
Putrid, sulphides	Inedible	0	< 4	> 21	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Cod, boxed

Species: **Cod** Gadus morhua	Applies to: **Boxed Fish**

Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for cod landed at European ports

Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC Grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	16	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	14	2 – 4	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	13	5 – 6	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	11	8 – 9	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	10	~ 11	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	8	~ 14	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	7	~ 16	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	5	~ 18	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	< 3	> 18	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 3	> 18	Not graded	
Putrid, sulphides	Inedible	0	< 3	> 18	Not graded	Putrid

Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.

Cod, normal handling

Species: **Cod** Gadus morhua	Applies to: **Normal handling**

Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for Cod landed at European ports

Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	15-16	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	13	2 – 4	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	11-12	5 – 6	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	10	8 – 9	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	8	~ 11	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	7	~ 14	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	5	~ 16	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	3-4	~ 18	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	< 3	> 18	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 3	> 18	Not graded	
Putrid, sulphides	Inedible	0	< 3	> 18	Not graded	Putrid

Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.

Cod fillets, skin-on (skin side)

Species: **Cod** Gadus morhua	Applies to: Skin-on fillets **(skin side)**

Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for cod landed at European ports

Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	15-16	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	13	2 – 4	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	12	5 – 6	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	10	8 – 9	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	9	~ 11	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	7	~ 14	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	6	~ 16	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	4	~ 18	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	< 3	> 18	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 3	> 18	Not graded	
Putrid, sulphides	Inedible	0	< 3	> 18	Not graded	Putrid

Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.

Cod fillets, bone side

Species: **Cod** Gadus morhua			Applies to: **Fillets, bone side**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for cod landed at European ports						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	8-9	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	6	2 – 4	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	3	5 – 6	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	2	8 – 9	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	1	~ 11	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	-	~ 14	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	-	~ 16	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	-	~ 18	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	-	> 18	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	-	> 18	Not graded	
Putrid, sulphides	Inedible	0	-	> 18	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Gilt Head Sea Bream (sparus aurata), normal handling

Species: **Gilt Head Sea Bream** Sparus aurata			Applies to: **Normal handling**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for Gilt Head Sea Bream.						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	14	1 - 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	13	2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	12	3 - 4	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	11	5 - 7	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	10	8 - 9	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	9	10 - 12	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	8	13 - 15	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	7 - 6	16 - 18	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	5 - 4	18 - 22	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	4 - 3	> 25	Not graded	
Putrid, Sulphides	Inedible	0	2 - 1	> 29	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Haddock & Whiting, boxed

Species: **Haddock & Whiting** Melanogrammus aeglefinus, Merlangius merlangus			Applies to: **Boxed fish**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for haddock & whiting landed at European ports						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	16	< 1	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	15	2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	13	4	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	11	7	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	10	~ 10	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	8	~ 13	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	6 - 7	~ 15	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	5	~ 18	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	< 3	> 18	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 3	> 18	Not graded	
Putrid, sulphides	Inedible	0	< 3	> 18	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Haddock & Whiting, normal handling

Species: **Haddock & Whiting** Melanogrammus aeglefinus, Merlangius merlangus			Applies to: **Normal handling**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for haddock & whiting landed at European ports						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	16	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	15	< 2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	11-12	4	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	8	7	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	7	~ 10	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	3-4	~ 13	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	< 3	~ 15	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	< 3	~ 18	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	< 3	> 18	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 3	> 18	Not graded	
Putrid, sulphides	Inedible	0	< 3	> 18	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Herring, 5% fat, boxed, unhandled

Species: **Herring** Clupea harengus			Applies to: **Boxed, unhandled, approx. 5% fat content**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for herring landed at European ports						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	14	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	13	< 2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	12	< 2	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	11	3	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	9	6	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	8	8	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	7	9	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	6	~ 10	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	5	~ 12	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 4	> 14	Not graded	
Putrid, sulphides	Inedible	0	< 3	> 14	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Herring, 10% fat, boxed, unhandled

Species: **Herring** Clupea harengus			Applies to: **Boxed, unhandled, approx. 10% fat content**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for herring landed at European ports						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	14	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	13	< 2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	12	2	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	11	3	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	10	4	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	9	5	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	8	6	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	6	9	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	5	~ 10	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 4	> 10	Not graded	
Putrid, sulphides	Inedible	0	< 3	> 12	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Herring, 15% fat, boxed, unhandled

Species: **Herring** Clupea harengus			Applies to: **Boxed, unhandled, approx. 15% fat content**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for herring landed at European ports						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	14	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	13	< 2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	12	2	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	11	3	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	10	4	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	9	5	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	8	6	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	7	7	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	6	9	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	5	~ 10	Not graded	
Putrid, sulphides	Inedible	0	< 4	> 10	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Herring, 20% fat, boxed, unhandled

Species: **Herring** Clupea harengus	Applies to: **Boxed, unhandled, approx. 20% fat content**

Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for herring landed at European ports

Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	14	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	13	< 2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	12	2	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	11	3	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	10	4	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	9	5	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	8	6	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	7	7	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	6	8	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	5	~ 10	Not graded	
Putrid, sulphides	Inedible	0	< 4	> 10	Not graded	Putrid

Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.

Herring, 25% fat, boxed, unhandled

Species: **Herring** Clupea harengus			Applies to: **Boxed, unhandled, approx. 25% fat content**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for herring landed at European ports						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	14	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	13	< 2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	12	2	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	11	3	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	10	4	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	9	5	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	8	7	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	7	8	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	6	9	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	5	~ 10	Not graded	
Putrid, sulphides	Inedible	0	< 4	> 10	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Herring, 30% fat, boxed, unhandled

Species: **Herring** Clupea harengus	Applies to: **Boxed, unhandled, approx. 30% fat content**

Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for herring landed at European ports

Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	14	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	13	2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	12	2	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	11	3	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	10	4	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	9	6	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	8	8	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	7	~ 10	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	6	> 10	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	5	> 10	Not graded	
Putrid, sulphides	Inedible	0	< 4	> 10	Not graded	Putrid

Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.

Ladyfish, normal handling

Species: **Ladyfish** Otolithus senegalensis			Applies to: **Normal handling**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for ladyfish.						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	14	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	13	< 2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	12	4	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	11	7	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	10	11	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	9	13	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	8	~ 18	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	7	~ 22	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	6	~ 25	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	5	~ 28	Not graded	
Putrid, sulphides	Inedible	0	< 4	> 28	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Mackerel, 8% fat, boxed, unhandled

Species: **Mackerel** Scomber scrombus	Applies to: **Boxed, unhandled, approx. 8% fat content**

Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for mackerel landed at European ports

Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	14	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	13	< 2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	12	3	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	11	4	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	10	5	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	9	6	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	8	7	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	7	~ 9	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	6	> 10	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	5	> 10	Not graded	
Putrid, sulphides	Inedible	0	< 4	> 10	Not graded	Putrid

Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.

Mackerel, 13% fat, boxed, unhandled

Species: **Mackerel** Scomber scrombus			Applies to: **Boxed, unhandled, approx. 13% fat content**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for mackerel landed at European ports						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	14	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	13	< 2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	12	2	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	11	2	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	10	3	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	9	5	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	8	6	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	7	~ 8	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	6	~ 10	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	5	> 10	Not graded	
Putrid, sulphides	Inedible	0	< 4	> 10	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Plaice, boxed

Species: **Plaice** Pleuronectes platessa	Applies to: **Boxed fish**

Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for plaice landed at European ports

Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	16	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	14	2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	13	4	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	11	7	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	11	~ 10	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	10-11	~ 13	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	10	~ 16	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	9-10	~ 18	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	8	> 18	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 6	> 18	Not graded	
Putrid, sulphides	Inedible	0	< 6	> 18	Not graded	Putrid

Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.

Place, normal handling

Species: **Plaice** Pleuronectes platessa			Applies to: **Normal handling**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for plaice landed at European ports						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	16	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	14	< 2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	11-12	4	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	10	7	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	8	~ 10	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	7-8	~ 13	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	7	~ 16	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	6	>18	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	< 6	> 18	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 6	> 18	Not graded	
Putrid, sulphides	Inedible	0	< 6	> 18	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Redfish, boxed

Species: **Redfish** Sebastes spp	Applies to: **Boxed fish**

Relationship between objective sensory scores for freshness, freshness Meter readings, and approximate times of storage in ice, for redfish landed at European ports

Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	16	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	14	2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	13	5	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	12	8	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	11	~ 10	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	10	~ 13	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	9	~ 15	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	8	~ 18	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	< 6	> 18	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 4	> 18	Not graded	
Putrid, sulphides	Inedible	0	< 3	> 18	Not graded	Putrid

Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.

Redfish, normal handling

Species: **Redfish** Sebastes spp			Applies to: **Normal handling**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for redfish landed at European ports						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	15-16	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	13	2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	11-12	5	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	10	8	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	8	~ 10	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	7	~ 13	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	5	~ 15	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	3-4	~ 18	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	< 3	> 18	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 3	> 18	Not graded	
Putrid, sulphides	Inedible	0	< 3	> 18	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Saithe, boxed

Species: **Saithe** Pollachius virens	Applies to: **Boxed fish**

Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for saithe landed at European ports

Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	16	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	14	2 – 3	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	13	4	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	11	7	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	10	9	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	9	10	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	8	~ 12	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	7	~ 14	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	4-5	~ 16	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 3	> 18	Not graded	
Putrid, sulphides	Inedible	0	< 3	> 18	Not graded	Putrid

Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.

Saithe, normal handling

Species: **Saithe** Pollachius virens			Applies to: **Normal handling**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for saithe landed at European ports						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	15	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	13	2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	11-12	4	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	8	7	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	7	9	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	6	10	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	4	~ 12	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	< 3	~ 14	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	< 3	> 16	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 3	> 16	Not graded	
Putrid, sulphides	Inedible	0	< 3	> 16	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Salmon, boxed

Species: **Salmon** Salmo, Oncorhynchus			Applies to: **Boxed Fish**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for cod landed at European ports						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC Grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	14	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	12	3	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	10	5	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	9	8	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	8	~ 11	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	7	~ 14	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	6	~ 16	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	5	~ 18	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	< 5	> 18	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 5	> 18	Not graded	
Putrid, sulphides	Inedible	0	< 5	> 18	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 1 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Salmon, normal handling

Species: **Salmon** Salmo, Oncohynchus	Applies to: **Normal handling**

Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice for salmon.

Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	14	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	12	3	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	10	5	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	9	8	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	8	~ 11	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	7	~ 14	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	6	~ 16	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	5	~ 18	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	< 5	> 18	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 5	> 18	Not graded	
Putrid, sulphides	Inedible	0	< 5	> 18	Not graded	Putrid

Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.

Sea bass (dicentrarchus labrax), normal handling

Species: **Seabass** Dicentrarchus labrax			Applies to: **Normal handling**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for Seabass.						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	14	1 - 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	13	3	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	12	4 - 6	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	11	7 - 9	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	10	10 - 12	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	9 - 8	13 - 15	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	7	16 - 18	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	6	18 - 22	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	5	22 - 25	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	4 - 3	26 - 29	Not graded	
Putrid, Sulphides	Inedible	0	2 - 1	> 29	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Sea bream (dentex spp.), normal handling

Species: **Sea bream** Dentex canariensis	Applies to: **Normal handling**

Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for sea bream.

Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	15	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	14	< 2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	13	2	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	12	4	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	11	8	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	10	~ 13	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	9	~ 17	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	5	> 17	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	< 3	> 17	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 3	> 17	Not graded	
Putrid, sulphides	Inedible	0	< 3	> 17	Not graded	Putrid

Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.

Sea bream (pagellus spp.), normal handling

Species: **Sea bream** Pagellus coupei	Applies to: **Normal handling**

Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for sea bream.

Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	13	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	12	3	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	11	8	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	10	11	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	9	15	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	8	~ 19	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	7	~ 22	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	6	~ 26	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	5	~ 29	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 4	> 29	Not graded	
Putrid, sulphides	Inedible	0	< 3	> 29	Not graded	Putrid

Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.

Spanish mackerel, normal handling

Species: **Spanish mackerel** Scomber colias			Applies to: **Normal handling**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for Spanish mackerel.						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	15	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	14	< 2	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	12	2	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	10	5	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	8	7	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	6	10	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	4	~ 12	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	2	~ 14	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	< 2	> 16	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 2	> 16	Not graded	
Putrid, sulphides	Inedible	0	< 2	> 16	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Tilapia, normal handling

Species: **Tilapia** Oreochromis lidole	Applies to: **Normal handling**

Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice for Tilapia.

Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	13	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	12	4	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	11	8	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	10	12	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	9	~ 17	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	8	~ 21	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	7	~ 26	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	< 7	> 26	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	< 7	> 26	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 7	> 26	Not graded	
Putrid, sulphides	Inedible	0	< 7	> 26	Not graded	Putrid

Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.

Threadfin bream (nemipterus), normal handling

Species: **Threadfin Bream** Nemipterus			Applies to: **Normal handling**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for threadfin Sea Bream.						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	13	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	12	3	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	11	8	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	10	11	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	9	14	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	8	~ 17	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	7	~ 19	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	6	~ 21	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	5	~ 23	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 4	> 25	Not graded	
Putrid, Sulphides	Inedible	0	< 3	> 29	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Trout, normal handling

Species: **Trout** Rainbow Trout - Salmon gairdneri			Applies to: **Boxed Fish**			
Relationship between objective sensory scores for freshness, Freshness Meter readings, and approximate times of storage in ice, for cod landed at European ports						
Raw odour description	Cooked flavour description	Taste panel score	Freshness Meter score	Days on ice	EC Grade	State of spoilage
Fresh sea-weedy odours	Watery, metallic, starchy. Initially no sweetness but meaty flavours with slight sweetness may develop	10	14	< 2	E	Very fresh
Shellfish odours and loss of fresh sea-weediness	Sweet, meaty, creamy, green plant characteristics	9	12	3	E	
No odours, neutral odours	Sweet and characteristic flavours but reduced in intensity	8	10	5	A	
Slightly musty, mousy, milky or caprylic, garlic, peppery	Neutral	7	9	8	A	Decrease in freshness
Bread, malt, beer, yeasty odours	Insipid, no flavours	6	8	~ 11	B	
Lactic acid, sour milk, or oily odours	Trace of "off" flavours, some sourness but no bitterness	5	7	~ 14	B	
Grass, "old boots", slightly sweet, fruity or chloroform-like odours	Some "off" flavours, sourness and bitterness	4	6	~ 16	Not graded	
Stale cabbage water, turnip, sour sink, wet matches, phosphene-like odours	Strong bitter flavours, rubber, sulphide-like	3	5	~ 18	Not graded	Nearly spoiled
Ammonia, strong "byre-like" odours		2	< 5	> 18	Not graded	
Strong ammonia, bad eggs (hydrogen sulphide)	Inedible	1	< 5	> 18	Not graded	
Putrid, sulphides	Inedible	0	< 5	> 18	Not graded	Putrid
Note: The influence of seasonal factors on freshness introduces a range of variation of ± 2 days in ice in the estimated values, for fish stored longer than 2 days in ice.						

Guidance for angling club competitions

The Fish Freshness Meter is used around the world as an objective measurement of freshness of fish caught at various angling competitions.

With ever increasing prize money at stake, many competitors try to beat the system by having a suitable fish caught and stored in ice (or frozen) outside the competition window. The fish is then presented as having been caught within the competition and the prize money claimed.

The Freshness Meter allows an objective method of assessing the relative freshness of the competition fish simply and easily. Also, the meter is exceptionally useful for identifying fish that have been previously frozen – such fish will yield a freshness score of 4 or less – even though the fish looks very fresh and wholesome.

We suggest that, before the competition date, you should have an organoleptic chart for the fish species that you intend to fish. If the fish species is not already specified in this manual then you need to prepare a new chart.

You can prepare a new organoleptic chart by using the Freshness Meter to measure one or two fish over a period of 1 to 2 weeks, as follows:

Procure one or two fish from the competition water.

Immediately store the fish in ice, and maintain at or just above 0°C. Do not allow the fish to become frozen as this destroys the cellular structure. The meter will display a value of 4 or less where fish have been allowed to freeze.

Measure the fish as recommended in this manual, ensuring that you measure consistently at the same position on the fish each time.

Measure the fish twice per day, in the morning and in the evening, and keep a note of the readings.

Continue the process until the fish is spoiled.

Use this information to prepare an organoleptic chart like the samples in this manual. If possible, have your new chart checked by an experienced fisherman or fish expert who can help validate your results.

Whether using an existing chart or a new chart of your own making, arrange that all fish caught during the competition are measured using the Freshness Meter. Use the organoleptic chart to assess the age of the fish.

Any fish that show a significant difference in freshness value from the average should be further investigated.

Technical Manual

Introduction

This Technical Manual has been written to cover some of the more advanced ways in which the Freshness Meter can be used.

The information here is not expected to be of particular interest to most users, and is aimed at researchers and other technical users.

There is, in addition, a large amount of information on the Distell website at http://www.distell.com. The website includes a 'Frequently Asked Questions' section, where we address many of the queries that have been raised in connection with the Freshness Meter.

If, after reading this document and the information on the website, you have questions about or problems with the Freshness Meter then please get in touch with us. Our contact details are at the end of this manual.

Creating Custom Calibrations

Note: a comprehensive guide on creating custom calibrations is available on our website at http://www.distell.com/downloads/CustomCalibrations.pdf. This online guide is written largely with the Distell Fatmeter in mind because, in general, custom calibrations are more useful to the Distell Fatmeter than the Freshness Meter. We recommend that this guide be read first and then further information can be taken from the online guide where needed.

Measurement methodology

Clearly define your measurement protocols

It is important to clearly define your measurement methodology for the product well in advance of the actual measurements.

The 'native' measurement scale for the Freshness Meter is the Torry Freshness Scale, which ranges from 1 (very spoiled) to around 16 (very fresh). In practice the upper limit of the scale varies from one fish species to another.

You will need to first decide what scale you want your calibration to represent. For the sake of an example, this section will describe a process to build a calibration representing 'time from death in days'.

Selecting your product samples

To create a calibration from scratch you will need some typical samples of product for the measurements. We recommend between 2 and 5 sample fish, and these samples should all be very fresh and they should have been killed at the same time.

The process could be performed with a single sample, but different fish will have different levels of bacteria and fat content, which can impact the readings from the Freshness Meter. Using multiple fish allows these variations to be averaged such that a single generic model of the fish is represented.

The sample fish should be stored on ice at around 0°C but they must not be frozen, otherwise the readings from the Freshness Meter will be unusable.

Measurement of samples using the meter

The procedure for collecting the data is similar to that for creating an organoleptic chart, as described in the User Manual.

All samples should be measured using the Freshness Meter's RESEARCH-1 calibration setting, and the meter should be configured to take 3 readings per sample.

The measurement process should be carried out twice each day, once in the morning and once in the evening. For our 'time from death in days' calibration there should be a 12-hour gap between each set of readings.

When the time comes to take readings:

- Record the desired value for the calibration at that time. For our example, this will be the time, in days, since the fish were killed, e.g. 1.5 days, 2 days, etc. Be reasonably precise at this stage; if the fish were killed 77 hours earlier then record 3.2 days rather than rounding off to the nearest half day.
- For each fish take three readings. Each reading should be taken from exactly the same position on each fish – usually a little above the lateral line at a meaty part of the shoulder. Record the individual readings, as well as the average for each fish. Then, once all the measurements are recorded, calculate the average for all the fish.

This cycle of measuring and recording should be repeated until the fish are sufficiently spoiled.

Prepare the data

When the measurements have all been taken then there will be a series of paired data points.

In our example, the paired data is (a) the time, in days, since the fish were killed, and (b) the average RESEARCH-1 reading on all the fish. If the measurements were carried out over 10 days then there will be 20 pairs of data.

Data components needed for a custom calibration

The custom calibration will be produced from three components:

- The Reference Calibration for your Meter, normally RESEARCH-1;
- The Reference Dataset, which is the series of averaged RESEARCH-1 values (the reference dataset comprises values taken from the reference calibration);
- The Analysis Dataset, which is the values you wish to represent in your calibration. In our example the analysis dataset is the series of numbers showing the time, in days, since the fish were killed.
- We will use the Data Management System to match up the pairs of data from the Reference Dataset and the Analysis Dataset.

Creating a custom calibration

- Each meter is shipped with the following calibration settings:
- Product settings
- A minimum of four standard product calibrations

Research settings

- •One research calibration, known as Research-1, and which is used for reference when creating your own custom calibrations

The data that makes up these product datasets is called a calibration. The DMS provides the capability to create a new calibration, and upload the calibration into the group of research settings.

The process of creating a custom calibration in the DMS follows. To begin, select 'Create Custom Calibration' from the File menu in the DMS. This will open the 'Custom Calibration Data' window.

The following steps should be followed:

1. The first stage is to load the Reference Calibration. You can use the 'Download' button to copy the RESEARCH-1 calibration directly from the meter, assuming it is attached via the supplied USB cable. Instructions are given on screen, but the process is quite simple:
    a. Click on the 'Download' button.
    b. Select 'Send Ref' from the meter's Choices menu
    c. Save the DCF file on your computer for future reference
    d. The data is now available in the Custom Calibration window. You can, for future work, either use the DCF file saved from this process or you can repeat the download.

If the reference calibration you used is not RESEARCH-1 then please get in touch with Distell for guidance.

If you are using an existing DCF file, e.g. one that you downloaded from the meter previously, click on the 'Browse...' button to navigate to the file then click 'Load' to load the reference calibration data from the file. Alternatively you can drag the file from the Windows desktop or a file explorer window and drop it on the Create Custom Calibration window.

2. The second stage is to select the reference calibration you wish to use. The .DCF file in stage 1 may contain multiple calibrations, though only those used in the Freshness Meter's Research menu are able to be used for this. Select the appropriate calibration from the drop-down list and the DMS will use this file as your Reference Calibration for calculating new custom calibration. You must choose the calibration setting that was used to take the measurements; typically this will be Research-1.
3. Using the table, enter the values for Reference Dataset in left hand column and Analysis Dataset in right hand column, for each pair of samples. The data is checked after each entry and any errors in the data will be highlighted in different colours; the key to the colours is shown below the data table. If the data shows no errors then the DMS will now create a calibration curve based upon data values entered, and the new custom calibration will be displayed in the form of a graph.

    There is an option to import this data from a CSV file, which may be more convenient for large datasets. The CSV file should be formatted as two columns with no header, the first column being the Reference value and the second column being the Analysis value.
4. The fourth stage, once the data has been entered, is to choose maximum and minimum threshold values. This allows you to limit the range of values in the calibration. Anything outside of your chosen range will appear as 'out of range' on the meter itself. The DMS will attempt to choose sensible values for these, but you can override them with your own choice if you wish.
5. The fifth stage is to enter the name of the new calibration. This is limited to 12 letters, symbols or numbers, due to the size of the display on the meters. The meter will show the calibration name given here on the display.
6. Select the grouping method according to instructions available in the Help Section of the DMS. Normally you will choose 'Separate'.
7. The seventh stage is to select the research setting, or slot, that the new calibration should use. Meters have, by default, 16 slots in the bank of research calibration settings. The first of these is always filled with RESEARCH-1, leaving 15 vacant slots. It is the user's responsibility to track which slots are filled and which are vacant.
8. You can now save the Data in two formats:

- For uploading your custom calibration to the meter using the DMS, save as a Distell Calibration File (.DCF). The uploading process is discussed in the next section.

- For exporting to a spreadsheet or database save as a Comma Separated Value file (.CSV). In this form, the data is presented as a series of 1000 discrete data points that reflects the measurement range of the meter.

The best-fit type is usually best left at Exponential, but you can use your own judgement for what shape best represents your data.

Uploading Calibrations to the Meter

Programming a meter with a new calibration setting

Note: a more comprehensive guide on uploading calibrations is available on our website at http://www.distell.com/downloads/UploadingCalibrations.pdf.

Your meter is shipped with several calibrations pre-installed, but if you have purchased an additional calibration, or you have created a custom calibration, then this option allows you to upload it to your meter.

Note: each calibration is unique to a specific meter because it has been tuned to the exact electronic profile of the sensor in the meter. You can upload a calibration to a different meter, but it will not give accurate results.

To upload a calibration to your meter, proceed as follows:

In the DMS

- Open the DMS, select the File menu, then Upload Calibrations.
- Locate the Custom Calibration file that you wish to upload. This should have a .DCF file extension. You can use the Browse... button to help you find the file. Once you have the filename, click Load to open the calibration file.
- The third step is to choose which individual calibrations from the file that you wish to upload to the meter. The file may contain more than one calibration, so only tick the calibrations that you wish to upload at this time.

In the meter

Once you have selected the calibrations to upload, switch the meter on and go to the 'Add Product' option of the Choices Menu on the meter, and press the Y (Read / Yes) button.

When you are ready to perform the upload, press the Y (Read / Yes) button at the 'Data Ready?' prompt.

When the meter shows 'Waiting data' you can click the Start button in the DMS to begin the upload. You can monitor the upload progress on the meter display, and also on the computer.

Note: If you cancel the upload before it is complete you will have an incomplete calibration in the meter and measurement results will be unpredictable and inaccurate. You should always allow the upload process to finish.

Document References

The following documents and papers may be of interest to anyone seeking further information on the work of assessing fish freshness.

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JASON A C and RICHARDS J C S, 1975

The development of an electronic fish freshness meter.

J. Phys. E: Sci. Instrum. 8 826-30

SANDERS H R and SMITH G L, 1976

The construction of grading schemes based on freshness assessment of fish.

J. Fd. Technol. 11 365-78

SHEWAN J M, MACINTOSH R G, TUCKER C G and EHRENBERG A S C, 1953

The development of a numerical scoring system for the sensory assessment of the spoilage of wet white fish stored in ice.

J. Sci. Fd. Agric. 4 283-98

Technical Specifications

Sensor

Type:	Carbon and steel electrodes
Output current:	< 1 mA

Display

Type	LCD, 2 lines x 16 characters

Sensor Enclosure

Material	ABS Plastic, waterproofed to IP 65
Size	180mm x 80mm x 35mm
Weight (including batteries)	280g

Hardware / Software

Capacity:	Up to 48 calibrations can be stored in each meter and up to 1000 data samples can be recorded before a download is required.
Software:	The Distell Data Management System is supplied with each meter, and is downloadable from our website.
Interface:	Distell meters are supplied with a waterproof USB cable that can be used for periodic downloads as well as real time data capture.
Batteries:	Powered by internal rechargeable batteries, Nickel Metal Hydride (NiMh)

Charger / Power Supply

Universal charger / power supply, also acts as desktop power supply unit.

Fitted with waterproof connector.

Input voltage:	110V – 250V AC, 50 – 60 Hz
Output voltage:	12 V DC, 1.25 A

Declaration of Conformity

The Products covered by this Declaration

The following Electrical / Electronic equipment, manufactured by Distell.com, for measurement, control and laboratory use:

- Fish Freshness Meters: Model: Torrymeter
- Fish Fatmeters: Models: FFM 692, FFM 992
- Meat Fatmeters: Models: MFM 1092, MFM 992

Directives and Standards to which these Products Conform

Directives

SAFETY	EEC	2014/35/EU
EMC	EEC	2014/30/EU
RoHS	EEC	2011//65/EU

Standards

SAFETY	EEC	EN 61010-1: 2010
EMC	EEC	EN 61326-1: 2013

Other Standards

Fish Freshness Meter FCC CFR47: 2011 - Part 15, Sub Part B (Class B) (US Federal code of regulations), consisting of: Clause 15.109

VCCI Agreement of VCCI: 2015.4 (Class B), in conformance with Table 4.6

DATE CE MARKING FIRST AFFIXED: December, 2000

LATEST UPDATE: January, 2017

David T. Fulton - General Manager

Distell.com, Old Levenseat, Fauldhouse,

West Lothian, EH47 9AD, Scotland – UK

Trading Terms and Warranties

In line with most manufacturers, the products that we manufacture and sell are covered by a comprehensive warranty. In order that all customers are fully aware of the terms and conditions of order acceptance, terms of sale and after-sales warranty, we have summarised below our current terms for reference.

Terms and Conditions of Order Acceptance

Orders

An order received by Distell.com (hereinafter referred to as 'The Company') is deemed to be an offer to purchase by the customer, and subject to the conditions herein contained which will be deemed to be accepted by the customer upon delivery of the goods.

Prices

The prices quoted are subject to stock availability and whilst every endeavour will be made to supply at quoted prices, The Company reserve the right to revise prices at any time prior to delivery, upon giving notice to the customer to that effect.

Terms of Payment

Payment for goods is cash with order. Payment for services is due prior to delivery or return despatch of goods on completion of services Any other terms of payment must be confirmed in writing from The Company prior to ordering goods and services. The Company reserves the right to charge interest on overdue accounts at the monthly rate of 5% above base rate.

Terms and Conditions of Sale

Retention of Title

The ownership of any goods supplied by The Company shall remain vested in The Company until full payment has been received. The customer shall be entitled to resell the goods or services only as agents of The Company and shall be bound to account to The Company therefore.

Risk

All risks in relation to the goods will pass to the customer upon delivery to the customer or his agents.

Delivery

Delivery shall be deemed to be effected when the goods have been delivered to the address agreed between the customer and The Company or when collected by or on behalf of the customer.

The Company will endeavour to deliver the goods without delay, but shall not be liable for late delivery howsoever caused, nor shall such failure be deemed to be in breach of any contract.

If for any reason the customer refuses delivery, then without prejudice to any other rights due to The Company, The Company reserves the right to treat the order as cancelled forthwith.

Returns

No returns of goods or services supplied by The Company will be accepted without The Company's prior written consent.

Liability for Loss or Damage

The Company does not accept liability for damage or partial loss of goods or services under the following circumstances:

- Where there is a clear signed receipt of delivery to the customer.
- Where the customer has signed for receipt of goods marked as unexamined.
- Where the customer fails to give notice of any damage or loss within three days of delivery.

Terms and Conditions of After Sales Warranty

Any warranty given is solely confined to the repair / replacement of any product supplied or manufactured by The Company, directly to the customer.

All equipment supplied or manufactured by The Company is covered by a twelve month warranty covering parts and labour. The warranty commences on the date of shipment or, where delivery is by The Company's own staff, from the date of delivery.

The Company warrant that the Equipment shall be free from defects in workmanship and materials. Any equipment that is demonstrably defective on receipt by the customer must be returned within seven working days of receipt of goods to qualify for a free of charge replacement.

Thereafter our sole responsibility shall be to repair or replace the defective product at our discretion, upon receipt at our premises. The faulty equipment must be received properly packaged, protected and insured from Transit Damage.

The Company accepts no responsibility under the warranty for any product that has been opened, tampered with, reprogrammed, altered modified or misused in any way, and in no event shall the company be liable for incidental, consequential, indirect or special damages including, but not limited to damage arising from the loss of use of the product, system or profits, or any claim against the company by any other party.

This warranty is in lieu of all other warranties, whether expressed or implied, including without limitation, implied warranties of merchantability and/or of fitness for a particular purpose.

Following the expiry of the manufacturer's warranty, we strongly advise our customers to avail themselves of our comprehensive service and maintenance contract. This contract covers your equipment and where applicable your installation, for a period of one, two or three years. Note that all labour and parts are covered by this service contract, but shipping, packaging and insurance are payable by the customer. For further details please contact our offices.

In the event of a warranty claim or a service requirement please contact our Returns Department. Details of address and telephone numbers are shown at the rear of this manual.

For a copy of the complete Terms and Conditions, please contact our sales office or distributor.

Contact details

The

TORRYMETER FISH FRESHNESS METER

is manufactured in the UK by

DISTELL.COM

Unit 5, Old Levenseat

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West Lothian

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Scotland

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