GUIDELINES FOR THE SENSORY EVALUATION OF FISH AND SHELLFISH IN LABORATORIES

CAC-GL 31-1999

GUIDELINES FOR THE SENSORY EVALUATION OF FISH AND SHELLFISH IN LABORATORIES

I. SCOPE AND PURPOSE OF THE GUIDELINES

The guidelines are intended to be used by analysts who need to apply sensory methods when using criteria based on sensory attributes of the products. Although the guidelines have been written with the Codex requirements in mind they include some provisions for products not covered by these standards but where sensory evaluation is used in the testing of fishery products for conformity requirements.[1] These guidelines are to be used for sensory examination of samples in a laboratory to determine defects by procedures, including cooking, which are not normally done by analysts in the field. Technical information is provided on the laboratory facilities used for such analyses and training of analysts.

The objective of guidelines is to ensure uniformity of application of standards by making recommendations for inspection purposes concerning the facilities required in sensory testing and the procedures for carrying out sensory tests.

For the purpose of this document the use of fish means finfish, crustaceans, and molluscs.

II. FACILITIES FOR SENSORY EVALUATION

2.1 GENERAL OBSERVATIONS

Sensory evaluation should be carried out by adequately trained personnel (see Section IV). They evaluate a specialized range of products, and use one sensory methodology.

2.2 LABORATORIES FOR SENSORY EVALUATION

2.2.1 Location and Layout

Figure 1 illustrates a plan of a laboratory that would be suitable for use for examining fishery products. The plan illustrates the principle that the preparation area should be separate from the evaluation area.

Office accommodation, storage rooms, staff facilities, and possibly other test facilities should be provided elsewhere in the premises. The evaluation area must not be used for chemical and microbiological analyses however, some types of analyses could be done in the preparation area.

2.2.2 Preparation Area

This area is to used for the handling and storage of fishery products, and for the preparation of samples for sensory evaluation. It should be constructed so as to comply with the requirements of good manufacture practices for the design and construction of fishery establishments. The rooms should be designed to ensure cooking odours do not interfere with sensory analysis.

[1] Additional criteria may be included if new recommendations are made by the Committee

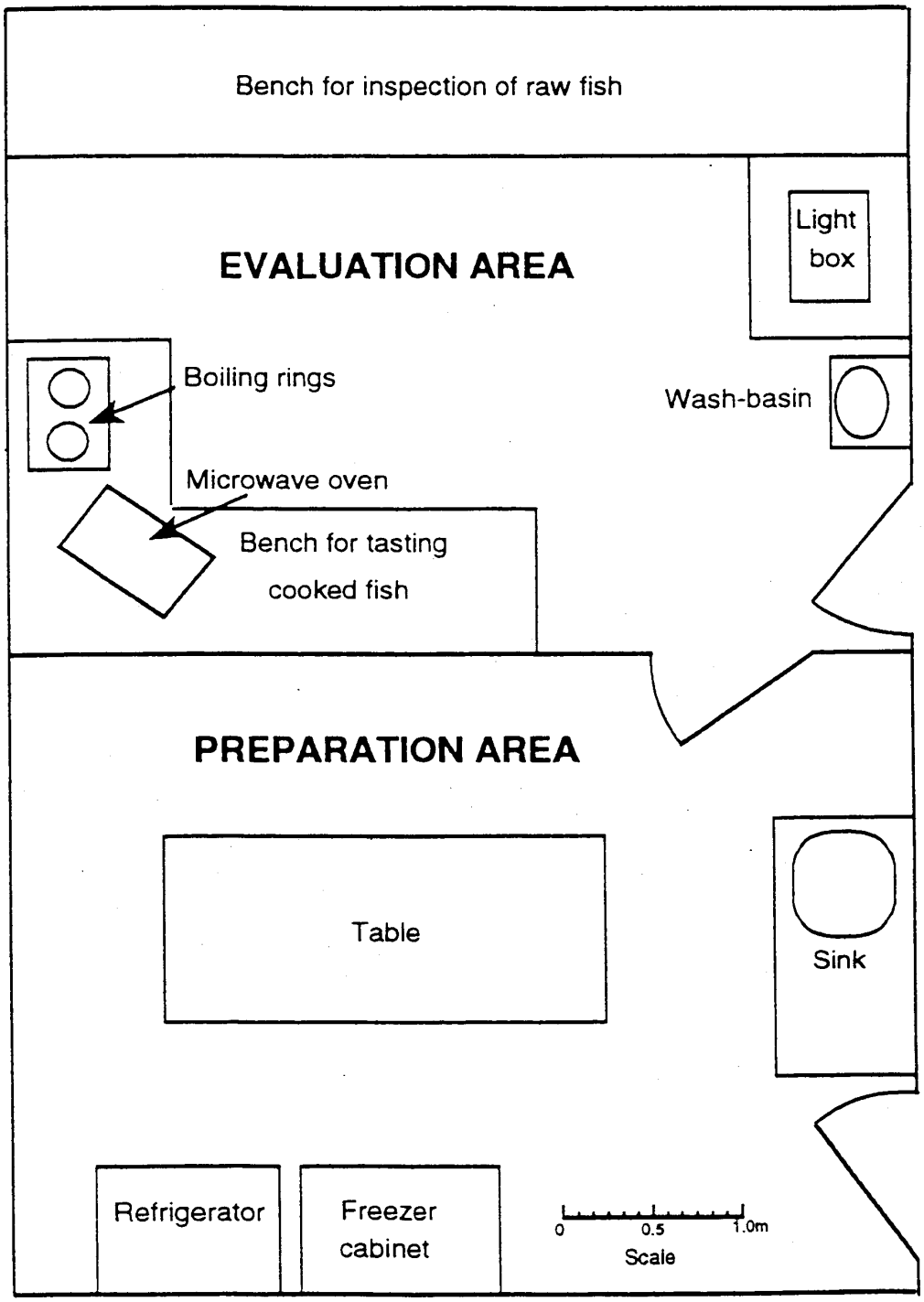
2.2.3 Evaluation Area

There should be no preparation of products in this area other than final trimming of samples prior to cooking.

The area, ventilation, procedures and sample sequence should be organized to minimize disturbing sensory stimuli. Also influence and disturbances from fellow evaluators and other personnel should be minimized. The colour of evaluation area should be neutral.

The working surfaces should be illuminated by daylight or artificial daylight. Any specific conditions in standards should be met.

Figure 1. Illustrative Plan of a Laboratory for Sensory Evaluation of fishery Products



2.2.4 Equipment

The exact type and amount of equipment required will depend to some extent on the nature of products to be inspected and the volume and frequency of the examinations.

III. PROCEDURES FOR SENSORY EVALUATION

3.1 COLLECTING AND TRANSPORTING SAMPLES

In most circumstances where fishery products are subjected to sensory evaluation a decision is made about a batch of fish, for example, acceptance or rejection of a consignment of imported products, classification of batches of fish on a market into freshness grades. The decision is made on the basis of an examination of a sample drawn from the batch according to guidelines which will usually specify how a sample is to be taken for the intended regulatory or commercial purpose of the examination.

When collecting a sample for inspection the inspector should ensure that the procedures used for taking the sample, and the subsequent handling of the sample, do not materially affect its sensory properties.

The inspector should check that the sample is properly packed and where necessary, under temperature control before dispatching it to the inspection laboratory. If the sample is not under the supervision of officials during transport the inspector should ensure that sample can not be tampered with during the journey.

On receipt at the inspection laboratory, samples, if not evaluated immediately, should be stored under appropriate conditions. However fresh and chilled products should be examined on the day they are received. Products in either chill or frozen storage should be appropriately wrapped to prevent drying out or desiccation.

3.2 PREPARATION OF SAMPLES FOR EXAMINATION

Table 1 in Annex 1presents attributes useful in evaluating some species and products. Procedures for preparation of samples should be appropriate for the product types. Some procedures relative to fresh or frozen finfish are described in the following paragraphs.

The fish, if entire, should be gutted and the guts retained. The head should be removed, and the fillet from one side to taken off. The portions should be assembled on tray for analysis.

QF Products can be laid out on the examination bench in the evaluation area, but it is often more convenient for presentation and for clearing up after if sample units are presented on trays.

Frozen products should be first examined in the frozen state. The complete sample unit or portions of the unit should then be thawed for sensory evaluation. Whether the sample can, or should be subdivided, depends on the nature of the products. Packs of IQF shrimps or fillets can be opened and subsamples taken. Portions could be sawn off large fish or off blocks, but this might be difficult in the case of thick material unless a bandsaw is available.

Frozen material should be thawed out as quickly as possible, but without raising the temperature of all or part of the product so that it might spoil. The simplest procedure is to spread out the sample units on the benches and tables in the preparation area and leave them to thaw at ambient temperature. They should be covered to prevent drying and contamination. The progress of thawing should be monitored and when it is judged that thawing is complete the products should be evaluated, or transferred to a refrigerator. Products should be covered with plastic film before storing in the refrigerator. Storage should be limited in order to maintain sample integrity. If possible sample units should be thawed out on trays so that the amount and nature of the thaw drip can be assessed.

Thawing can be accelerated by immersion of the material in water. This is acceptable if product is protected from the contact with water by suitable wrappings, or if contact with water does not materially affect the sensory properties of the product. Care must be taken to prevent further spoilage or bacterial growth. Small sample units such as IQF fillets or small packs of shrimps or shellfish meats could be thawed in a microwave cooker on the defrost setting, but care must be taken not to use too high power settings otherwise parts of the material will be overheated.

Large frozen fish or large blocks of frozen products will take many hours to thaw out at ambient temperature, longer than a normal working day, and they can not be properly monitored throughout the whole process of thawing. One solution is to lay the products out for thawing at the end of a working day when they will just be completely, or almost completely, thawed by the following morning. Alternatively the material can be put out to thaw as early as possible in the day and transferred to a chill room at the end of the day to complete the process at low temperature. It is helpful to break apart blocks of product when they are partially thawed to accelerate thawing if this can be done without damaging the material.

3.3 COOKING

In cases where a final decision on odour or gelatinous state cannot be made in the thawed uncooked state, a small portion of the disputed material (approximately 200g) is sectioned from the sample unit and the odour and flavour or gelatinous condition confirmed by cooking without delay by one of the following cooking methods. The following procedures are based on heating the product to an internal temperature of 65 - 70 °C. The product must not be overcooked. Cooking times vary according to the size of the product and the temperatures used. The exact times and conditions of cooking for the products should be determined by prior experimentation.

Baking Procedure: Wrap the product in aluminum foil and place it evenly on a flat cookie sheet or shallow flat pan.

Steaming Procedure: Wrap the product in aluminum foil and place it on a wire rack suspended over boiling water in a covered container.

Boil-in-Bag Procedure: Place the product in a boilable film-type pouch and seal. Immerse the pouch in boiling water and cook.

Microwave Procedure: Enclose the product in a container suitable for microwave cooking. If plastic bags are used, check to ensure that no odour is imparted from the plastic bags. Cook according to equipment instructions.[2]

[2] General Standard for Quick Frozen Fish Fillets, Annex A "Sensory and Physical Examination"

3.4 PROCEDURES FOR THE ASSESSMENT OF PRODUCTS

Standards and specifications for fishery products will specify the features of the product that are able to be evaluated, and the criteria for accepting or rejecting products or for allocating them to grades. Table 1 presented in Annex I lists sensory attributes and criteria which may apply to standards and quality grading schemes. In order to apply quality criteria consistently in the inspection of products it is necessary to conduct the sensory assessments in a consistent and systematic manner. Samples should be assessed relative to the characteristics of the species concerned.

Assessors must pay particular attention to those features of the product which are referred to in any standards and which determinate conformance to the standard, but in addition they should assess and record other relevant attributes of the samples, as appropriate.

3.4.1 Assessment of Raw Products

Fresh fish will normally be assessed by appearance and odour. Fish change in appearance in a number of ways during spoilage in ice and it is not usually difficult to accurately grade iced fish by appearance alone. Characteristics to look for are listed in Table 1 of Annex I.

3.4.2 Assessment of Frozen Products

Frozen fish should be examined in the frozen state. The assessor should note the nature and state of any wrappings and glazes and the product should be examined for any discolourations and for the extent and depth of any dehydration. The assessor should note if there are any signs that product might have been thawed and refrozen. Signs of slumping or distortion of blocks, the collection of frozen drip in pockets in the wrappings, (not to be confused with water that might have been present on the fish at the time of freezing), and the partial loss of glaze.

Thawed samples should be presented and examined as for the corresponding unfrozen product where appropriate. It is not easy to evaluate the freshness of thawed whole fish by appearance because the freezing and thawing processes alter characteristics like the eyes, skin and colour of gills and blood. The gills have a leathery or slightly rancid odour even after short periods of frozen storage which have no significance for the quality of the product.

3.4.3 Assessment of Cooked Samples

Cooked samples should be held in a closed container, allowed to cool to a comfortable tasting temperature, and kept warm unless they are assessed immediately. Products which have already been cooked, for example cooked shrimps, should be warmed up slightly.

The assessor should note the appearance of the product and record any unusual features. The odour should be assessed and its character and strength recorded, particularly any unusual odours like chemical taints. Assessors should be encouraged to taste cooked samples as some compounds can only be detected by mouth (e.g. low levels of decomposition or fuel contamination).

The flavor of a sample in the mouth should confirm the assessment based on odour, but can give additional information. For example most additives such as salt, sorbates, polyphosphates, are not detectable by odour,

but are detectable by taste. Sensory analysis alone should not be used to determine the presence of additives and any suspicion that non permitted additives have been used, or that excess amounts of permitted additives are present, should be confirmed by chemical analysis where appropriate.

IV. TRAINING OF ASSESSORS

4.1 OBJECTIVE SENSORY TRAINING

4.1.1 Considerations for Objective Sensory Training

In the sections below examples are provided of test materials which have been used for screening and training analysts.

Objective sensory testing measures the intrinsic sensory attributes of a sample through the analytic sensory perceptions of human assessors. In order to conduct objective sensory analyses of fish and fish products, assessors must be selected for their ability to perform the sensory tasks required, must be trained in the application of the required test methods, and must be monitored for their ongoing ability to perform the sensory tasks. Thus, sensory training includes:

(a) The selection of assessors for basic sensory acuity and for the ability to describe perceptions analytically i.e. without the effect of personal bias. Allergies to seafood or to some food additives could eliminate an analyst candidate.

(b) The development of the analytical capability by familiarization with test procedures, improvement of ability to recognize and identify sensory attributes in complex food systems, and improvement of sensitivity and memory so that he/she can provide precise, consistent, and standardized sensory measurements which can be reproduced.

(c) The monitoring of the assessor's performance and the consistency of their analytic decisions by the frequent periodic assessment of the sensory decisions.

4.1.2 Selection of Candidate Assessors

A candidate for assessor training should demonstrate that he/she:

1. is not anosmic (unable to perceive odours) - so that odours of decomposition and other defects will be perceived and described in a consistent manner;

2. is not ageusic (unable to perceive basic tastes) - so that tastes associated with decomposition and other defects will be perceived and described in a consistent manner;

3. has normal colour vision and is able to detect anomalies in the appearance of fish and fish products in a consistent manner,

4. is able to rely on sensory perceptions and to report them appropriately;

5. is able to learn terminology for new or unfamiliar perceptions (odours, tastes, appearances, textures) and to report them subsequently; and

6. is able to define sensory stimuli and relate them to an underlying cause in the product.

The first five points can be measured in testing, the last ability is developed during specific product training.

In conducting the tests, it is useful to allow for repetition of the tests for basic taste and for odour perception. This is necessary to ensure that the candidate is being tested for basic ability and not responding to an unfamiliar testing situation. New code numbers and presentation sequences are used in each test method.

4.1.2.1 Screening for Perception of Basic Tastes

The diversity of flavours, especially of defects from decomposition, which the inspector will be required to perceive and describe make it essential that some indication of the general ability to perceive basic tastes be established. One area of particular importance in selection and training is the ability to discriminate bitter and sour tastes/flavours as this is a common area of confusion in inexperienced assessors. These tastes/flavours are critical in the examination of fish and fish products as they are evident in the early stages of decomposition.

A matching standards test using concentrations which should be perceived by a normal taster has been described by several standard sources. The concentrations used have been shown in testing to be perceptible.

Table 1 A selection of published test solutions used for screening and training analysts

Basic Tastes	Standard Compounds Used (in water)	DFO Screening Tests (1986-96)	Meilgaard et al. (slight to very strong) (1991)	Jellinek (1985)	ASTM (1981)	Vaisey Genser and Moskowitz (1977)
Bitter	caffeine	0.06%	0.05 to 0.2%	0.02 & 0.03%	0.035, 0.07 & 0.14%	0.150%
Sour	citric acid	0.06%	0.05 to 0.20%	0.02, 0.03 & 0.04%	0.035, 0.07 & 0.14%	0.01%
Salt	sodium chloride	0.02%	0.2 to 0.7%	0.08 & 0.15%	0.1, 0.2% 0.4%	0.1%
Sweet	sucrose	2.0%	2.0 to	0.40 & 0.60%	1.0, 2.0 & 4.0%	1.0%
umami*	monosodium glutamate	0.08%				

* This has been identified by some analysts as being a fifth basic taste, however this remains controversial. This **may** be used as part of the selection procedure, but should definitely be used as part of the training sessions to illustrate the contribution to the flavours of fish contributed by the ribonucleotides.

4.1.2.2 Screening for Perception of Odours

In this case, several types of tests are available which will accomplish the selection procedure.

Because people are able to perceive a very large number of separate odour qualities, the samples used should be chosen to be both representative of common odours with which the candidate would likely have had experience, and also be representative of odour qualities which occur as defects in fish and fish products. Two examples two test methods which would be appropriate for use in assessing odour perception are presented in Annex II.

4.1.2.3 Screening of Normal Colour Perception

Colour blindness is measured by the use of one of several standard ophthalmologic tests including the Ishihara Colour Blindness Test and the Farnsworth-Munsell 100-Hue Test. These tests may be purchased through medical supply sources and should come with complete instructions as to their use. They must be administered under the exact conditions specified in the instructions.

4.1.2.4 Screening Test for the Assessment of Texture

There can be cases when fish is rejected for texture. These are tests which are essentially done by touch on raw product. Characteristics which may be assessed include:

(a) firmness: in fresh fish and shellfish (shrimp); and
(b) springiness: in fresh fish.

One such test is the procedure designed by Tilgner (1977) and reported in Jellinek (1985). This test used a series of samples which increase slightly in firmness and uses pressure with the forefinger of the dominant hand to assess firmness and allow the candidate to rank the samples from least to most firm. This allows the assessment of the concept of firmness and the concept of increasing intensity in a sensory attribute. The samples used in the test described are permanent samples cast from polyvinyl chloride although a series of samples can also be generated from appropriate food samples.

4.1.3 Training of Assessors

A *Suggested Syllabus for a Training Course for Assessors in the Sensory Assessment of Fish and Fishery Products* The following is a model training syllabus. The length of the basic sensory science training which is included in the course can vary from the 10 hours (1.5 days) shown below to full length courses of university level training. It is suggested that hands-on exercises accompany each section to demonstrate the concept under discussion (e.g. prepare basic taste solutions and have the students taste them during the lecture on taste). A Suggested Syllabus for a Training Course for Assessors in the Sensory Assessment of Fish and Fishery Products is presented in Annex III.

4.1.4 Monitoring of Assessors

The validation of the effectiveness of sensory training and of the consistency of sensory assessments is achieved through ongoing monitoring of the sensory decisions made by the assessor. This may be accomplished in a variety of ways, either singly or in combination.

(a) The first is the use of check samples which are samples of known quality which are distributed to inspectors for examination in their day-to-day testing facility. The results are sent back to the central coordinator of the samples for analysis. The advantage of this method is that samples are being assessed under the actual laboratory conditions. Samples used for this are prepared using the procedures described in Section 4.2, Preparation and Handling of Samples. Also commercial product of known quality and which is available in sufficient quantity may be used.

(b) Another procedure which is used to validate the performance of an inspector is through actual accreditation testing and calibration procedures. These are conducted in a central location laboratory which is large enough to accommodate all of the inspectors participating in the test. Samples are prepared using the procedures described in Section 4.2 Preparation and Handling of Samples. Also commercial product of known quality and which is available in sufficient quantity may be used. This procedure must be repeated at regular intervals to ensure that no change has occurred in the inspectors' ability to evaluate products and the inspector must reach a pre-defined level of performance on both «pass/accept» samples and «fail/reject» samples.

(c) A supplementary method of evaluation of an inspector's performance is the accumulation over time of the on-going inspection results vs. any other known information on samples, e.g. reinspection results, consumer complaints, chemical analyses, etc.

4.1.5 Reference Documents

Reference documents are presented in Appendix II.

4.2 PREPARATION AND HANDLING OF SAMPLES

4.2.1 Type of Samples

Samples used for the purpose of training individuals in sensory techniques concerning fishery products are the single most important factor to be considered. It is imperative that proper samples be provided in reference to sensory training.

There are two types of samples to be considered in the training of sensory analysts or inspectors.

1. Controlled spoilage samples: These samples should display or represent a full range of quality, as well as the normal range of product characteristics related to odour, flavor, appearance, and texture.

It is essential that samples of excellent quality be provided as a reference point during the preparation of such packs.

Quality defects should be naturally occurring, if possible, to exhibit sensory characteristics which are typical of the product to be used. If the samples are spoiled or contaminated artificially, they may not exhibit typical sensory properties for both the acceptable or unacceptable units to be used for training.

It is important for the individual preparing the samples to have knowledge of the normal commercial processing of the product to be spoiled from harvesting to freezing and be aware of processing methods and conditions under which spoilage usually occurs. Understanding the general pathways of decomposition would be useful in the preparation of controlled spoilage samples.

When possible, controlled spoilage, samples should be prepared where the product is harvested and processed to allow for the species, flora, etc. to duplicate normal spoilage conditions that allows for typical odours of decomposition as well as other characteristics that mimic commercial samples.

2. Commercial samples: Whenever possible, the use of commercial samples should be incorporated into the sensory training of individuals. Many times, quality defects (odour, flavor, appearance, texture, etc.), as well as taints (musty/mouldy odours, flavours, rancidity, petroleum distillates, etc.) can be best shown with commercially produced samples that have these defects. These commercially manufactured samples allow one to assess sensory personnel during training by providing «real life» samples. They can also be used to measure an individual's retention abilities as it relates to making correct decisions in sensory science.

Many times, quality defects and taints are not found in all intensities in controlled spoilage samples but can be shown in slight, medium, and strong intensity from commercially produced samples.

4.2.2 Preparation of Sample Packs

Sample preparation should be started in plenty of time to allow one to obtain the majority of defects as well as allowing product to go through a curing process if necessary.

If possible, the spoilage run should be conducted with fish «in the round» to allow for natural spoilage to occur. This allows for typical spoilage odours to form.

(1) Baseline

It is essential that excellent quality material of all species and product forms of known history, without commercial abuse, be obtained to provide a constant reference to the workshop participants. Whenever possible, both fresh and frozen product forms should be included in the preparation of controlled spoilage samples. The lot should be uniform with respect to its quality at the start of the run.

Proper record keeping is essential in the preparation of spoilage samples. Samples of each code taken should be consistent within a set, each succeeding set representing a longer period of time that the product has been held under ambient or iced conditions. Temperature monitoring is essential to prevent fluctuations during each spoilage run.

Spoilage must be accomplished under appropriate conditions of temperature and environmental contamination if authentic spoilage effects are to be obtained. Variations in spoilage rates between individual units can be minimized if the starting material is of uniform size and quality and contact between individual units is maintained during spoilage.

Fish tend to spoil at different rates so one should examine product at regular intervals and group the product together that have similar characteristics prior to processing. Expert evaluation of the samples is constantly needed at this stage.

The number of increments needed will depend on the purpose of the training and the species to be examined but a minimum of 5 increments and as many as 8 may be needed. At least 50% of the pack should be of acceptable product.

(2) Spoilage

Generally, both high and low temperature decomposition spoilage should be included, but knowledge of the species and the standard processing method and at what point of the process is spoilage most likely to occur should determine the general spoilage method. It is important to avoid «shortcuts» for the sake of convenience. If pre-chilling spoilage is the issue, the use of frozen fish must be avoided. Careful temperature control is a necessity.

(3) Packaging and Storage

The species and type of product from a spoilage run should be taken into account to determine the amount of shelf life one can expect.

Canned products should be allowed to cure in the can for at least 30 days prior to use. They should be stored in a cool and dry location with a temperature range of 14°C - 18°C, otherwise one can expect a much shorter storage life. Maximum shelf life of canned seafood products for training purposes is approximately 2 years. After this amount of time, characteristics develop that may affect one's judgement or render the samples of little value for training purposes.

Unless freezer storage damage is intended to be demonstrated, raw and pre-cooked frozen products should be properly glazed to prevent dehydration and freezer burn. Depending on the length of storage, the samples may require periodic reglazing to ensure the quality. If possible, product should be vacuum packed to ensure quality and is essential in the storage of some fish species as well as pre-cooked samples.

Both raw, precooked and canned controlled spoilage samples should be evaluated by a qualified individual prior to use in a workshop. The samples should have both chemical analysis and sensory results to determine the quality of the increment and the homogeneity of the increment.

4.2.3 Characteristics of Samples

4.2.3.1 Sensory Attributes

A. Must show normal odour, flavor, appearance, texture, etc. characteristics of the species to be used for samples.

B. If product forms normally show characteristics attributed to harvest location, feed odours, etc. include with the controlled spoilage samples if possible.

C. Samples which exhibit odours of spoilage or contamination defects must not be too intense to the point of overpowering the participant's senses and affecting judgement of other samples during a training session.

D. Samples showing slight to moderate odours of spoilage or contamination provide more of a challenge and better represent «real world» conditions.

E. Each increment or code must show consistent or similar characteristics to have value when used for training.

4.2.3.2 Chemical Attributes

Inclusion of chemical attributes of authentic pack samples can be useful in training (see Annex III Section II Practical Exercises from the model Syllabus).

A. Chemical indicators of decomposition (CID) are selected that are essentially absent in the fresh product.

B. A CID is selected that will monitor the decomposition pathway of interest in the particular products to be used for training. Methods are used which are capable of differentiating between the CID levels found in passable, slightly abused-passable and the first definite stage of decomposition. When possible it is preferable to use two CID's.

C. The CID should be retained in the processed forms (washed/cooked/canned/stored) of the fishery product to be examined.

D. The changes in a CID should track the changes in sensory quality in the fishery product.

E. A sufficient number of subsamples should be analyzed for each increment of prepared sample to measure the degree of variation within sample increments. This is especially important for those increments representing the transition from a passable product to the first definite stage of decomposition.

Annex I

Table 1. Examples of Attributes of Fishery Products Used in Sensory Evaluation[3]

Vertebrate fish, iced

Presentation	Feature	Criteria and description
Raw whole, gutted or ungutted	outer surface, skin	colour: bright, dull, bleached slime: colourless, discoloured damage: none, punctures, abrasions
	Eyes	shape: convex, flat, concave brightness: clear, cloudy colour: normal, discoloured
	belly cavity	guts (in intact fish): intact, digested cleanliness (in gutted fish): completely gutted and cleaned, incompletely gutted, not washed belly walls: bright, clean, discoloured, digested parasites: absent, present blood: bright, red, brown
	texture, appearance of gills	skin: smooth, gritty, flesh, firm, soft colour: bright red or pink, beached, discoloured mucus: clear, opaque, discoloured
	odour of gills	fresh, characteristic, neutral, slightly sour, slightly stale, definite spoilage, putrid
Raw fillets	Appearance	translucent, glossy, natural colour, opaque, dull, blood-stained, discoloured
	Texture	firm, elastic, soft, plastic
	Odour	marine, fresh, neutral, sour, stale, spoiled, putrid

[3] References to be included for the clarification of sensory properties, as established by ISO

Cooked fillets	Odour	spoilage: marine, fresh, neutral, musty, sour, spoiled taints: absent, disinfectant, fuel oil, chemicals, sulphides
	Flavour	spoilage: sweet, creamy, fresh oil, neutral, sour, oxidised, putrid, musty, fermented, rancid, bitter, taints: absent, disinfectant, fuel oil, very bitter, alkaline, polyphosphates, chemicals
	Texture	succulent, firm, soft, pasty, gelatinous, dry

Vertebrate fish, frozen

Frozen	Appearance	freezer burn: absent, slight, superficial, extensive, deep colour: normal, yellow to bronze discolouration in fatty fish
Thawed fillets, raw	Texture	firm, elastic, flexible, very firm, hard, stiff drip: slight, moderate, abundant odour spoilage and taints: as for chilled fish cold storage: absence of cold storage odours, sharp, cardboardy, rancid
Thawed fillets	odour and flavour	spoilage and taints: as per chilled fish cold storage: absence of cold storage odours, sharp, cardboardy, rancid
	Texture	firm, succulent, tough, fibrous, dry

Crustacean shellfish, chilled

Raw	Appearance, shell on	bright colours, slight blackening on the head, blackening on head and body
	Appearance, peeled meats	translucent, overall white or light grey, slight black discolouration, extensive black discolouration, very translucent, slimy, yellowish discolouration on butt end of tail meat taken from head-on products
	Odour	fresh, marine, musty, ammoniacal, sour, spoiled, putrid
Cooked meats	Appearance	white, opaque, blacks spots, extensive back discolouration, slightly translucent
	Odour	fresh, boiled milk, musty, ammoniacal, rancid, sour, spoiled
	Flavour	sweet, creamy, neutral, musty, sour, bitter, spoiled
	Texture	firm, elastic, soft, mushy

Crustacean shellfish, frozen

Criteria specific to the grading of frozen shellfish, and their descriptions, are essentially the same as those applied to the grading of frozen vertebrate fish.

Cephalopods, fresh or refrigerated

Colour	skin: bright, dull, bleached meat: pearly white, lime coloured, pinkish or light yellow
Adherence	adherent to the meat, easily separating from the meat
Texture	meat: very firm, firm, slightly soft tentacles: resistant to tearing off, can be torn off easily
Odour	fresh, seaweed, slight or no odour, sour

Annex II

EXAMPLES OF TEST METHODS WHICH WOULD BE APPROPRIATE FOR USE IN SCREENING ASSESSORS FOR ODOUR PERCEPTION

1. The following is a list of samples as used in Canada:

(a) canned salmon (fish)
(b) canned sardines (fish/smoke)
(c) yeast (growth of yeasts)
(d) coffee (common product - to illustrate the method)
(e) orange & pineapple (fruity odours)
(f) cucumber & asparagus (vegetable odours)
(g) vinegar, cinnamon, pepper & cloves (pungent odours which can be differentiated)
(h) vanilla (sweet odour)
(i) prepared mustard (strong vinegar component, illustrates ability to perceive in mixtures)
(j) acetone, rubbing alcohol (contaminants, solvents)
(k) petroleum product (fuel oils)
(l) old vegetable oil (rancid oil)

In this test, the candidate is asked to identify the samples only by the odour as all visual information is masked. The sample are then identified and discussed with the candidate and the number of correct identifications recorded. During this step the candidate is given the opportunity re-examine any of the samples. The test is repeated after a time period such as 2 or 4 hours (during which other selection tests or interviews may be given), and number of correct responses recorded. The improvement in test scores which should occur (unless all were correct on the first round) gives an indication of the ability of the candidate to learn new terms to describe sensory perceptions.

2. The University of Pennsylvania Smell Identification Test, a standardized test for assessment of odour perception, is available from Sensonics, Incorporated, 155 Haddon Avenue, Haddonfield, New Jersey, 08033 USA.

Annex III

SUGGESTED SYLLABUS FOR A TRAINING COURSE FOR ASSESSORS IN THE SENSORY ASSESSMENT OF FISH AND FISH PRODUCTS

I. LECTURES

Part I: Theoretical Principals and Laboratory Practices of Sensory Assessment (10 Hours)

A. Basic Sensory Testing Principles:

1. Affective or subjective testing (test types, information gained, data collection, respondent type and numbers, decision-making possible from this information).

2. Analytical or objective testing (test types, information gained, data collection, respondent type and numbers, decision-making possible from this information).

   i. Discriminative testing: types of information that is gained and that is not.
   ii. Descriptive testing: qualitative and quantitative.

3. The role of the fish and seafood assessor or product expert in sensory testing.

B. Action of the Senses and the Perception of Sensory Properties of Fishery Products:

1. The physiology of the senses - sight, smell, taste, touch and hearing;
2. The perception of sensory properties - appearance/colour, odour, flavor, texture; and
3. Sensory interactions.

C. Sample Evaluation techniques:

1. Odour evaluation techniques.
2. Flavor evaluation techniques.
3. Texture evaluation (firmness and springiness).
4. Special techniques for seafood samples.

D. Basic Psychophysics of Sensory Assessment:

1. Thresholds; detection and recognition.
2. Intensity; the logarithmic nature of character strength perception.
3. Saturation; explanation of the phenomenon.

E. Factors Influencing Sensory Judgements:

1. Physiological effects; blending; masking, carry-over, enhancement and suppression.

2. Psychological effects; expectation, stimulus, halo, order, proximity, stimulus, logical, suggestion, contrast and convergence, and central tendency.

3. Control of physiological and psychological effects.

F. Basic Data Collection and Analysis:

1. Discriminative methods: triangle (3-alternative forced choice or balanced design), duo-trio, two-out-of-five, paired comparison):

   i. Ballot information and design types
   ii. Analysis of data

2. Descriptive methods: Flavor Profile, Texture Profile, Spectrum, QDA:

   i. Scales; category, line, magnitude estimation
   ii. Ballot information and design types
   iii. Analysis of data

3. Sensory methods for quality control - general discussion.

G. Terminology and the use of reference standards. the analyst should «understand the role of sensory descriptors as an aid to developing long term sensory memory and as a means of communicating results». (see Appendix 1):

1. Terminology development (including internationally recognised sources for known terms).
2. The importance of definitions
3. The use of reference Standards
4. Overview of terms relevant to seafood quality, with specific attention to those associated with low levels of decomposition.

H. Sample Handling and Preparation:

1. Presentation and coding.
2. Randomization of samples; purpose and occasion for use.
3. Homogeneity of samples and serving temperature.
4. Sample size and quantity.

Part II: Deterioration of Fish and Fish Products (3 Hours)

A. Composition of Fish and Shellfish:

1. Major components: protein, fat, carbohydrate, water.
2. Minor components; non-protein nitrogenous compounds, minerals, vitamins.

B. Pathways of Quality Deterioration:

1. Breakdown of protein, fat, non-protein nitrogenous compounds, and, for some species, carbohydrates.

2. Microbial spoilage.
3. Terminology associated with each type of spoilage pathway.

C. Chemical Indicators of Fish Quality and the Correlation of these with Sensory Data.

Part III: Contamination and Taint (1 Hour)

A. Types:

1. Naturally-occurring (muddy-earthy off-flavours).
2. Man-made (petroleum, pulp and paper effluent, other processing effluents).

B. Mechanism of flavor and odour changes.

C. Testing methods for contamination and/or taint (special considerations).

II. PRACTICAL EXERCISES

Part I: Presentation of Seafood Related Terminology, Clear Definitions, and References Which Demonstrate the Terms (2 hours)

Part II: Spoilage and Decomposition (18 hours)

This portion of the course provides hands-on experience. It is suggested that only one species at a time be evaluated.

This section may include whole fish, fillets, canned fish and/or smoked fish and other specialty products. Whenever possible, trainees should evaluate flavor as well as odour, e.g. especially in products such as canned fish packed in oil as the packing medium can mask odours.

The following sequence of three session formats are suggested for each species and will require approximately 4 hours in total. It is suggested that the effectiveness of the training be evaluated by testing the trainee's ability to assess sample quality correctly before moving on to another species:

(a) Demonstration session: Group demonstrations of samples of known quality by an experienced product expert. The labelled samples should represent a full range of quality, in order from highest to lowest quality, with discussion of sensory results, descriptors, as well as any data from chemical indicators of quality which are appropriate for that species.

(b) Discussion session: Random presentation of blind-coded samples for individual evaluation an group discussion of the results.

(c) Testing session: individual evaluation of blind-coded test samples and comparison of results with product expert.

The collection and analysis of data with detailed discussions of the samples will provide feed-back to the trainees.

Part III: Deterioration in Frozen Stored Fish and Shellfish (4 hours)

A. Demonstration of varying degrees of defects in appearance, odour, flavor, and texture caused by frozen storage of seafood products.

B. Include both low-fat and high-fat fish and seafood samples.

C. Have available terminology, definitions, and references for the oxidation process and for textural changes.

Part IV: Deterioration in Canned Fish and Shellfish (4 hours)

A. As for section II, and also to include information on pre- and post- processing deterioration.

Part V: Other Defects (2 hours)

A. Detection of taints using spiked samples (assess by odour only).

B. Demonstration of visual defects.

Appendix 1

DEFINITIONS OF SOME OF THE TERMS USED IN SENSORY ANALYSIS OF SEAFOOD

Appearance	All the visible characteristics of a substance/sample;
Analyst/ Assessor	Any person taking part in a sensory test;
Bilgy	The aromatic associated with anaerobic bacterial growth, which is illustrated by the rank odour of bilge water. The term «bilgy» can be used to describe fish of any quality which has been contaminated by bilge water on board a vessel. Bilge water is usually a combination of salt water fuel, and waste water;
Bitter	One of the four basic tastes, primarily perceived at the back of the tongue, common to caffeine and quinine. There is generally a delay in perception (2-4 seconds);
Briny	The aroma associated with the smell of clean seaweed and ocean air;
Chalky	In reference to texture, a product which is composed of small particles which imparts a drying sensation in the mouth. In reference to appearance, a product which has a dry, opaque, chalk like appearance;
Cucumber	The aroma associated fresh cucumber, similar aromas can be associated with certain species of very fresh raw fish;
Decompose	To break down into component parts;
Decomposed	Fish that has an offensive or objectionable odour, flavor, colour, texture, or substance associated with spoilage;
Distinct	Capable of being readily perceived;
Feedy	«Feedy» is used to describe the condition of fish that have been feeding heavily. After death, the gastric enzymes first attack the internal organs, then the belly wall, then the muscle tissue. If the enzymes have penetrated into the flesh, they are capable of causing quality changes dimethyl (DMS), and may be attributed to certain zooplankton as it passes through the food chain. The odour of «feed» fish has been described as similar to certain sulfur containing cooked vegetables, such as broccoli, cauliflower, turnip, or cabbage;
Fecal	Aroma associated with feces;
Firm	A substance which exhibits moderate resistance when force is applied in the mouth or by touch;

Fish Means any of the cold-blooded aquatic vertebrate animals commonly known as such. This includes Pisces, Elasmobranchs and Cyclostomes. Aquatic mammals, invertebrate animals and amphibians are not include;

Fishy Aroma associated with aged fish, as demonstrated by trimethylamine (TMA)or cod liver oil. May or may not indicate decomposition, depending on species;

Flavor An attribute of foods resulting from the stimulation of taste, smell, sight, pressure, and often warmth, cold or mild pain;

Freshness Concept relating to time, process, or characteristics of seafood as defined by a buyer, processor, user, or regulatory agency;

Fruity Aroma associated with slightly fermented fruit. Term is used to describe odours resulting from high temperature decomposition. Example = canned pineapple;

Gamey The aroma and/or flavor associated with the heavy, gamey characteristics of some species such as mackerel. Similar to the relationship of fresh duck meat as compared to fresh chicken meat;

Glossy A shiny appearance resulting from the tendency of a surface to reflect light at 45 degree angle;

Grainy A product in which the assessor is able to perceive moderately hard, distinct particles. Sometimes found in canned seafood products;

Intensity The perceived magnitude of a sensation;

Iridescent An array of rainbow like colours, similar to an opal or an oil sheen on water;

Intensity The perceived magnitude of a sensation;

Masking The phenomenon where one sensation obscures one or several other sensations present;

Mealy Describes a product that imparts a starch-like sensation in the mouth;

Metallic Aroma and/or taste associated with ferrous sulphate or tin cans;

Moist The perception of moisture being released from a product. The perception can be from water or oil;

Mouldy Aroma associated with mouldy cheese or bread;

Mouth coating The perception of a film in the mouth;

Mouth filling The sensation of a fullness dispersing throughout the mouth. A umami sensation, as stimulated by MSG;

Mushy Soft, thick, pulpy consistency. In seafood little or no muscle structure discernible when force is applied by touch or by mouth;

Musty The aroma associated with a mouldy, dank cellar. Product can also have a musty flavor;

Odour Sensation due to stimulation of the olfactory receptors in the nasal cavity by volatile material. Same as aroma;

Off odour/ Atypical characteristics often associated with deterioration or transformation of a flavor product;

Opaque Describes product which does not allow the passage of light. In raw muscle tissue of fishery products, this is usually due to the proteins loosing their light reflecting properties due to falling pH;

Pasty A product which sticks together like paste in the mouth when mixed with saliva. Forms a cohesive mass which may adhere to the soft tissue surfaces of the mouth or fingers;

Persistent Existing without significant change; not fleeting;

Pungent An irritating, sharp, or piercing sensation;

Putrid Aroma associated with decayed meat;

Quality A degree of excellence. A collection of characteristics of a product that confers its ability to satisfy stated or implied needs;

Rancid Odour or flavor associated with rancid oil. Gives a mouth-coating sensation and/or a tingling perceived on the back of the tongue. Sometimes described as «sharp» or «painty»;

Reference Either a sample designated as the one to which others are compared, or another type of material used to illustrate a characteristic or attribute;

Rotting vegetable Aroma associated with decayed vegetables, in particular the sulfur containing vegetables, such as cooked broccoli**,** cabbage, or cauliflower;

Rubbery A resilient material which may be deformed under pressure, but returns to its original form once the pressure is released;

Salty The taste on the tongue associated with salt or sodium;

Sensory Relating to the use of the sense organs;

Slimy A fluid substance which is viscous, slick, elastic, gummy, or jelly-like;

Sour An odour and/or taste sensation, generally due to the presence of organic acids;

Stale Odour associated with wet cardboard or frozen storage. Product can have a stale flavor as well;

STP Sodium tripolyphosphate. Can produce a soapy, alkaline feel and taste in the mouth;

Sweet The taste on the tongue associated with sugar;

Taste One of the senses, the receptors for which are located in the mouth and activated by compounds in solution. Taste is limited to sweet, salty, sour, bitter and sometimes umami;

Terminology Terms used to describe the sensory attributes of a product;

Translucent Describes an object which allows some light to pass, but through which clear images can not be distinguished;

Transparent Describes a clear object, which allows light to pass and through which distinct images appear;

Umami Taste produced by substances such as monosodium glutamate (MSG) in solution. A meaty, savory, or mouth filling sensation;

Watermelon Aroma characteristic of fresh cut watermelon rind. Similar odours are sometimes found in certain species of very fresh raw fish;

Yeasty/ fermented Aroma associated with yeast and fermented products such as bread or beer.

Appendix 2

REFERENCE DOCUMENTS

ASTM Atlas of odour character profiles, publication DS 61, PCN 05-061000-36. Complied by Andrew Dravnieks.

ASTM Committee E-18, 235, draft of terminology document.

ASTM Aroma and Flavor Lexicon for Sensory Evaluation DS 66. G.V. Civille and B.G. Lyon, eds.

ASTM Committee E-18 on Sensory Evaluation of Materials and Products, 1981. STP 758 - Guidelines for the Selection and Training of Sensory Panel Members.

ASTM Committee E-18 on Sensory Evaluation of Materials and Products, Terminology Committee, (date?). Draft definition for «Expert» and «Expert Assessor».

Cardello, A. 1993. Sensory methodology for the classification of fish according to edibility characteristics. *Lebensmittel-Wissenschaft-und-Technologie* 16, 190-194.

Department of Fisheries and Oceans, Canada. Code of practice for fishery products.

Department of Fisheries and Oceans, Canada. Regulations respecting the inspection of processed fish and processing establishments.

Department of Fisheries and Oceans, Canada, Inspection Branch. 1986 to 1995. Notes from «*Sensory Methods in Fish Inspection*» - Sensory Training course given by the National Centre for Sensory Science, Inspection Branch, Department of Fisheries and Oceans, Canada.

Howgate, Peter 1992. Codex review on inspection procedures for the sensoric evaluation of fish and shellfish. CX/FFP 92/14.

IFST - International Institute of Food Science and Technology. «Sensory Quality Control: Practical Approaches in Food and Drink Production». Proceedings of a joint symposium at the U. of Aston, 6-7-January, 1977. Session II, «Measurement of Fish Freshness by an Objective Sensory Method». P. Howgate, p. 41.

ISO 5492 (1983) Sensory analysis - vocabulary.

ISO 8586-2 Sensory Analysis - General guidance for the selection, training and monitoring of assessors - Part 2. Experts

Jellined, G. 1985. *Sensory Evaluation of Food - Theory and Practice.* Ellis Horwood, Ltd., Chichester, England.

Johnsen, et al., 1987. A lexicon of pond-raised catfish flavor descriptors. J. Sensory Studies 4, 189-199.

Laverty, 1991. «Torry Taste Panels». In Nutrition and Food Science, Vol 129 No. 2-4. Includes terminology based on odour of gills in raw, iced cod.

Learson, Robert 1994, personal correspondence. NOAA/NMFS Research Laboratory, Gloucester, MA.

Multilingual guide to EC freshness grades for fishery products. Torry research station, Aberdeen, Scotland and the West European Fish Technologists Association (WEFTA). Compiled and edited by P. Howgate, A. Johnston, and K.J. White.

NOAA Handbook 25, part 1, Inspection.

NOAA/NMFS, Technical Services Unit.

Kramer and Liston, (eds) Seafood Quality Determination. Proceedings of the International Symposium on Seafood Quality Determination, Coordinated by the University of Alaska Sea Grant College Program, Anchorage. Alaska, 10-14 November, 1986.

Learson and Ronsivalli, (1969), A new approach for evaluating the quality of fishery products.

Meilgaard, M., Civille, G.V., and Carr, B.T. 1991. *Sensory Evaluation Techniques*. CRC Press, Inc., Boca Raton, FL.

Poste, L., Mackie, D., Butler, G. and. Larmond, E. 1991. Laboratory Methods for Sensory Analysis of Food. Agriculture Canada Research Branch.

Prell and Sawyer, 1988 «Flavor Profiles of 17 Species of North Atlantic Fish» J. Food Science, 53, 1036-1042.

Prell and Sawyer (1988). Consumer evaluation of the Sensory Properties of Fish» J. of Food Science 53, 12-28, 24.

Reilly, T.I. and York, R.K. 1993. Sensory analysis application to harmonize expert assessors of fish products. Proceedings of «Quality Control and Quality Assurance of Seafood», May 16-18, 1993, Newport, Oregon (Eds. Sylvia, G., Shriver, A.L. and Morrisey, M.T.)

Sawyer et al.., (1988) «Consumer evaluation of the sensory properties of fish». J. of Food Science, Vol. 53. No. 1

Sawyer, F.M. et al. 1981. A comparison of flavor and texture characteristics of selected underutilized species of North Atlantic fish and certain treatment of fish. International Institute of Refrigeration. Paris, France. p. 505.

Shewan et al., (1953), The development of a numerical scoring system for the sensory assessment of the spoilage of wet white fish stored in ice. J. Sci. Food Agric., 4 June.

Soldberg, et al. (1986), Sensory profiling of cooked, peeled and individually frozen shrimp». In Seafood Quality Determination, Elsevier Science Publishers.

Vaisey Genser, M. and Moskowitz, H. R. 1977. Sensory Response to Food. Forster Publishing Ltd., Zurich, Switzerland.

Wilhelm, Kurt, 1994, personal correspondence. NOAA/NMFS Research Laboratory, Gloucester, MA.