‘Eating Quality’ of Fish–
A Review

Jette Nielsen
Grethe Hyldig
Erling Larsen

ABSTRACT. The quality of fish is a very complex concept. Quality is frequently described using terms related to nutritional, microbiological, biochemical and physiochemical characteristics alone, but none of these terms serve as adequate indices of quality-sensory perception and consumer acceptability must be included. This paper discusses some of the sensory methods that can be used for fish as objective markers of quality in the chain from catch to consumer with focus on methods used for evaluation of whole raw fish and suggest methods and systems that can build a bridge between research and development, industry, marketing and consumer. [Article copies available for a fee from The Haworth Document Delivery Service: 1-800-HAWORTH. E-mail address: <getinfo@haworthpressinc.com> Website: <http://www.HaworthPress.com> 2002 by The Haworth Press, Inc. All rights reserved.]

KEYWORDS. Sensory quality, sensory wheel, Quality Index Method, fish, quality

INTRODUCTION

It is well known that food quality is by no means clearly defined, and great confusion can be created when research and development try to communicate
with marketing. Botta (1995) cites 15 different definitions of quality. These range from general statements to consumer definitions. Each definition is convincing as far as it goes, but none of them are comprehensive. The term cannot be defined simply, as the definition changes with the particular context where it is applied, the multitude of species, and the influence of the biological parameters such as season and spawning period, in combination with technological parameters that must be considered. Quality of fish is therefore a very complex concept (Bremner, 2000). The concept is frequently described using terms related to nutritional, microbiological, biochemical and physiochemical characteristics alone, but none of these terms serve as adequate indices of quality-sensory perception and consumer acceptability must be included. Quality must be defined in each chain link from catch to consumer and to develop quantitative test methods suitable for all links of the chain are needed.

What is eating quality? For a consumer, ‘eating quality’ of fish is associated with freshness (Peary et al., 1994; Nielsen et al., 1997; Olafsdottir et al., 1997)–fish must be prepared and eaten directly out of the sea. It is, however, not the attitude consumers have when they buy fish; analysis of the market shows even frozen fish has a considerable market share (Grainger, 1999). Looking into Food Science and Technology abstracts back to 1969, there are 788 references using ‘eating quality’; most as a concept used for correlation of chemical and physical measurements of meat (e.g., Dalen, 1996), fruit and vegetables. The determination of eating quality in these is performed by internal and external panels, experts and by consumers. In the literature of market research and sensory science the term is very seldom used and it cannot be found in a dictionary. The apparent direct meaning of the term is to eat quality, but people do not eat ‘quality’ as such. People choose foods that have attributes and properties that are desired and associated with quality. Another approach is needed, and it would be better if direct expression of properties or group of properties replaces eating quality (Bremner, 2001).

Sensory evaluation of product characteristics can be used in research and development for determination of quality attributes. It is, although, clear that there are instances where the sensory evaluation of fish must consider both intrinsic (species, fat content, smell, appearance) and extrinsic quality cues (price, convenience, origin, handling) when a product (Figure 1) is under investigation (Ophuis and Van Trijp, 1995). Nevertheless the traditional and well-established sensory science used for evaluation does not need to be changed, since it is essential in many situations and cheap (Martens, 1999). However, another generation of sensory evaluation seems to be necessary to make the link between research and development and marketing (Meiselman, 1994; Deliza and MacFie, 1996; Schutz, 1998). The purpose of this paper is to discuss some of the sensory methods that can be used for fish as objective markers of quality in the chain from catch to consumer with focus on methods used for evaluation of whole raw fish
and to suggest methods and systems that can build a bridge between research and development, industry, marketing and consumer.

**SENSORY METHODS USED IN THE CHAIN FROM CATCH TO CONSUMER**

Fish is different from all other food commodities in the method of harvesting, the fragility of the product during transport to processing sites and further in the chain, the temperature dependency and the variety of species. Sensory assessment of fish and fish products has therefore for years played a natural part of the fishery chain.

Sensory testing can be both objective and subjective. The objective tests include discriminative (triangle test, forced choice) and descriptive (profiling, structured scaling) sensory tests. Both groups of test are analytical measurements of the intrinsic quality of the product, whereas affective (subjective test) methods are used for consumer testing and measure the attitude and emotional response of the consumer towards the product. All these methods are used in the fishery chain (Figure 2). Each link in the chain has its own version as indicated by the numbers of the different methods (discriminative test 1, discriminative test 2, etc.) and a co-ordination is needed.

The sensory analysis of fish can also be categorized in a system based on the kind of assessors involved (modified after York and Sereda, 1993):
Consumers: *Does the product experience fulfil the expectation? Are the product liked and/or chosen?*
- Interview, acceptance test, preference test

Trained assessors comparing products: *Is there a difference?*
- Triangle test, ranking, paired comparison

Extensively trained assessors: *What is the difference and how big is it?*
- Structured scaling, profiling

Expert assessors, highly trained, working as professional in evaluation of special attributes, defects and overall fish quality: *Does the product fulfil the quality standard?*
- Structured scaling, rating, compromise methods.

**FIGURE 2.** Sensory analyses in the chain from catch to consumer.
In analytical sensory studies, a trained panel objectively describes attributes of products whereas consumer studies use untrained human beings that answer subjectively, for example, how much they like/dislike a product. Sensory analytical methods do not depend on whether assessors like or dislike a certain item. Instead, it operates with determining intensities of attributes as sweetness, amine (fishy), sourness, softness, etc. Correlation between analytical and hedonic tests may be found when data from both areas are analyzed by multivariate data analysis.

**Profiling**

Descriptive profiling is very useful in research and industrial product development. It can be very simple and used for assessment of a single attribute of texture, flavor and appearance or many sensory attributes can be evaluated in each sample. One method of profiling, QDA (Quantitative Descriptive Analysis), provides a detailed description of all flavor characteristics in a qualitative and quantitative way (Meilgaard et al., 1999). Profiling has been used in several different studies of fish and fish products. The sensory attribute, such as appearance, texture and flavor, is highly species specific and can be measured in detail using sensory profiling. Solberg et al. (1986) studied the effect of freezing on shrimps using a combination of flavor and texture profiling and reducing 45 sensory attributes to 13 using multivariate analysis. Prell and Sawyer (1988) described flavor profiles for 17 fish species and were able to divide the species in four groups by characteristic notes. Profiling has been used making a flavor profile of fish oil (Rørbaek et al., 1993), for fresh water species (Chambers and Robel, 1993), salmon (Milo and Grosch, 1996), and lately to construct a fish sensory wheel (Figure 3) with the ability of describing five fish species (Warm et al., 2000): cod (*Gadus morhua*), saithe (*Pollachius virens*), rainbow trout (*Salmo gairdneri*), herring (*Clupea harengus*) and flounder (*Platichthys flesus*) with variation in storage time in melting ice.

Analogous to flavor wheels for wine (Noble et al., 1987) and beer (Meilgaard et al., 1979), the sensory properties of fish described in a sensory wheel can be used to give an overview of the sensory attributes of a fish species after similar attributes.

The wheel can be used on different levels and is divided into tiers based on the levels of details required. Appearance, taste, odor and texture make the first tier, which is the most general. On the second tier the sensory attributes are summarized in a superior theme, and on the third, the sensory attributes are found. It is therefore easy to see how the attributes in the vocabulary are connected. The advantage of the wheel with 18 words is that the words discriminate between the five fish species and between different storage times in ice. A product developer
FIGURE 3. Sensory wheel for 5 fish species with 18 words for appearance, odor, taste and texture (adapted from Warm et al., 2000).

can use the wheel in new product development when creating appearance-, taste-, odor- and texture-attributes of a new product. The wheel gives a product developer a basis for choosing sensory properties that a new product shall contain. When comparing the intensities of the sensory properties of the five fish species in new products, it can be seen which species is suited for a specific product. In consumer research the wheel can help to determine the sensory properties that correlate with consumers preference, e.g., in a correlation of a profiling and preference of the five fish species. In fish research the sensory wheel gives the researcher a general understanding of the sensory properties of the five fish species and gives the basis for construction of a quality index method-QIM (Hyldig and Nielsen, 1998) for cooked fish.
Structured Scaling

For quality measurement a descriptive test called structured scaling is most often used. Structured scaling gives the assessors an actual scale showing several degrees of intensity. A few detailed attributes are chosen, often based on work from a fully trained descriptive panel or from experts. Descriptive words must be carefully selected and panelists trained so that they agree with each other about the terms. For raw fish, a large number of schemes for sensory analysis have been developed. Shewan et al. (1953) developed the first modern and detailed scoring scheme utilizing sensory analysis evaluating fish quality. The research of Shewan et al. was also the starting point of an inspection programme in the EU. Grading fish for quality level through the application of government or industry-developed grading system, as part of the marketing process, predates the development of modern sensory science (Schutz, 1998).

The newest method of structured scaling for quality measurements is the quality index method (QIM). The Tasmanian Food Research Unit in the mid 80s originally developed QIM (Bremner et al., 1986) and since the late 80s staff in the seafood laboratories in the Nordic and European countries have further developed the method. At the Danish Institute for Fisheries Research the method has been tailored to the seafood industry needs, for instance, to fit the production of herring and frozen cod products. It is now widely used in Europe both for fresh herring, saithe and cod (Jonsdottir, 1992; Larsen et al., 1992) and frozen cod (Warm et al., 1998), for red fish, sardines and flounder (Nielsen, 1993) and recently for Atlantic mackerel, horse mackerel and European sardine (Andrade et al., 1997).

QIM is a very fast sensory method, which can be used for prediction of shelf life. QIM is based on significant sensory parameters for whole fish using many weighted parameters and a score system from 0 to 3 demerit points. The scores for all the characteristics are added to give an overall sensory score, the so-called quality index. QIM gives scores of zero for very fresh fish and an increasingly larger total result as the fish deteriorate. An example of the evaluation scheme for cod is seen in Table 1.

The selection of parameters for QIM is determined as a combination of the best descriptors for the spoiling fish, which also fulfil the aim that it is possible to predict the remaining shelf life. The remaining shelf life (in days on ice) can be calculated on the basis of this line and knowledge about the corresponding quality index at the time of rejection. There is a linear correlation between the sensory quality expressed as the quality score and storage time on ice, which makes it possible to predict remaining shelf life on ice. It is foreseen that the QIM will be useful to give feedback to fishermen concerning the quality of their catch, which may influence better handling on board. A so-called ‘catch-index’ containing QIM points may contribute to quality assurance in the whole chain. Fish process-
ing plants would also like to control the freshness stage of their raw material.
QIM-evaluation of raw material kept on ice will provide accurate and precise in-
formation concerning the freshness and a prediction of the freshness of fillets
later to be inspected by the buyers. Sensory evaluation might also here contribute
to a 'processing index.'

QIM is also suggested as a reference tool for verifying a quality labelling of
fish. Several investigations (Bisogni et al., 1986; Myrland et al., 2000) show that
the consumer wants to rely on 'expert' declaration of quality and a label may
have the desired effect because it is perceived as reassurance for consumers’ per-
ception of quality.

Developments and possibilities provided by modern computer technology has
made it possible to develop an Internet version of QIM that can be accessed at
<www.dfu.min.dk/qim>. Furthermore, an European project “QimIT” worked with
the QIM on a PC for integrated quality management in the seafood chain
(http://www.qim.eurofish.com/).

Rating

Rating gives an overall degree of difference from a standard or control product
(Munoz et al., 1988). The method is best applicable when a constant standard is
available (very seldom with fish and fish products) and is best suited to standard

TABLE 1. Quality index scheme for whole fresh cod (Gadus morhua).

<table>
<thead>
<tr>
<th>Quality parameter</th>
<th>Demerit point</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td></td>
</tr>
<tr>
<td>Skin color</td>
<td>0-2</td>
</tr>
<tr>
<td>Slime</td>
<td>0-3</td>
</tr>
<tr>
<td>Blood (in open cuts)</td>
<td>0-2</td>
</tr>
<tr>
<td><strong>Texture</strong></td>
<td></td>
</tr>
<tr>
<td>Skin/elasticity</td>
<td>0-2</td>
</tr>
<tr>
<td>Stiffness</td>
<td>0-1</td>
</tr>
<tr>
<td>Flesh</td>
<td>0-3</td>
</tr>
<tr>
<td><strong>Odor</strong></td>
<td></td>
</tr>
<tr>
<td>Abdomen</td>
<td>0-3</td>
</tr>
<tr>
<td><strong>Eyes</strong></td>
<td></td>
</tr>
<tr>
<td>Brightness</td>
<td>0-2</td>
</tr>
<tr>
<td>Shape of pupil</td>
<td>0-2</td>
</tr>
<tr>
<td><strong>Gills</strong></td>
<td></td>
</tr>
<tr>
<td>Color</td>
<td>0-2</td>
</tr>
<tr>
<td>Smell</td>
<td>0-3</td>
</tr>
<tr>
<td>Slime</td>
<td>0-2</td>
</tr>
<tr>
<td><strong>Sum of demerit points</strong></td>
<td>0-27</td>
</tr>
</tbody>
</table>
commodity products with a single or few sensory characteristics. Rating needs highly qualified expert assessors, and it is a common “pitfall” in the liability of the method when laymen use it.

The EU scheme is a rating method and the most common system used by fishermen and experts in the inspection service because they are required to use it. The scheme was introduced in Council decision No. 103/76 of January 1976 with a modification in Council decision No. 2406/96 September 1996. There are 3 levels in the EU-scheme: E (Extra), A and B, where E is the highest quality and below B is the level where fish are rejected for human consumption. The design of the EU scheme cannot be used in Quality Assurance (QA) in the processing industry, and is not suitable for this purpose (Howgate, 2000). The EU scheme is wrongly used in research laboratories in Europe as a structured scale when the users attach numbers to the grades and carry out arithmetic on these numbers.

A reasonable compromise between the quality rating method, used by experts, and a comprehensive descriptive approach as profiling might be a quality scoring with attribute scales for quality evaluation (Lawless and Heymann, 1998). This procedure uses a scale for overall quality, accompanied by a group of diagnostic scales for individual attributes. These attributes must be key sensory components known to the fishery chain. The scale range is usually match, acceptable, unacceptable, reject. As the correct use is dependent on extensive training and needs either a standard reference or wide experience, expert assessors can only use these methods. A recent example is seen in a study on hake (Ruiz-Capillas and Moral, 2001) where expert assessors in a mixed hedonic and descriptive analysis examine whole fish. The Danish 10-point scale (Huss, 1995) is also a typical example (Table 2). Each score from 0-10 is defined with few sensory attributes. In addition, the scores are divided into three grades of acceptability. Consequently, the scheme includes both analytical and acceptability aspects mixing hedonic and descriptive analysis and can only be recommended for expert use.

Inspection must be performed by a highly trained expert assessor (York, 1995), working as a professional in the evaluation of a particular commodity or product group. The enhanced awareness of the need for and the role of the expert assessor in fish and fish products have been demonstrated by ISO and Codex Alimentarius. ISO has agreed on a standard ISO/DP 8586-2 for selection, training and monitoring of experts and the Codex code of practice for fish gives guidelines for the sensory evaluation of fish and fish products (Howgate, 1994). The role of sensory analysis by experts is hereby recognized as an important tool in the fish inspection service.

Consumer Test

Consumer perception of fish and fish products has not been thoroughly studied. Issues related to the sensory cues used to describe different fish species combined with what factors influence the consumption are not described in detail. In the literature few descriptions of the factors influencing the consumer’s choice
are found. Wesson et al. (1979) found that texture was the influential factor for fresh fish without off-flavor, while flavor was the major factor when, e.g., rancid flavor is present. Other studies (Connell and Howgate, 1971; Hamilton and Bennett, 1983; Sawyer et al., 1988) found that flavor was the most significant determinant. Sawyer et al. (1988) also found a good correlation between the data of a trained sensory panel and a consumer panel using 13 sensory attributes evaluating 16 species. In a study of concept mapping of the term fish quality, Bisogni et al. (1986) showed the very different meanings these words had to different groups of assessors. The consumer response is more holistic and looks at attributes, which deal with how the product will be used. The expert response was, in contrast, focused on intrinsic attributes.

It has been suggested that marketing require sensory techniques that are fundamentally different from the techniques developed in traditional sensory analysis (McBride and MacFie, 1990; Van Trijp and Schifferstein, 1995). However, there is a relationship between product characteristics and sensory evaluation; a sensory test can also act as an information source and communication means in marketing. A simplified QIM (Table 3) for consumer testing (C-QIM) has recently been suggested by Warm (2000) as such a method. The first development of QIM (Bremner et al., 1986) was on the basis of cooperation between industry and research. An obvious consideration has been how this relates to the consumers’ perception. This question can now be partly answered with the modification of QIM to a consumer version, the C-QIM. C-QIM is developed with the use of an external panel testing their own vocabulary in comparison with QIM terms of experts.

TABLE 2. Compromise between rating and a descriptive method to be used by expert assessor.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>No off-flavor</td>
<td>Match Characteristic of species, fresh, seaweed</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Loss of flavor</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Neutral</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Slight off-flavor</td>
<td>Acceptable Off-flavor mousy, bready, sour, fruity</td>
<td>5</td>
</tr>
<tr>
<td>Severe off-flavor</td>
<td>Reject Strong off-flavor, cabbage, ammonia, sulphides</td>
<td>3</td>
</tr>
</tbody>
</table>
The important characteristics for both consumer and sensory scientist were appearance, odor and texture. These selected key parameters described intensity and gave an overall evaluation of fish quality and fulfills thereby the need for a method not mixing analytical and hedonic terms. C-QIM is not an acceptance test, but a tool for decision making for the consumer buying fish in a market or at a fishmonger. Further attempt to combine QIM for raw fish, profiling for cooked fillet and C-QIM might therefore prove to be a successful in ‘translating’ values for sensory quality through the chain.

‘TRANSLATION’ BETWEEN QUALITY DETERMINATION, CONSUMER DEMAND AND PRODUCT DEVELOPMENT

A method for ‘translation’ between quality determinations in the chain, consumer demand and the criteria used for product development will be very useful. Consumer driven approaches in product development and quality perception have relied on systems like QFD (quality function deployment) (Bech et al., 1997a,b) and interviews with groups of consumers and experts (Bisogni et al., 1986; Sawyer et al., 1988; Grunert and Grunert, 1995; Van Trijp and Schifferstein, 1995). Jaeger et al. (2000) suggest a combination of these methods in order to identify the product key characteristics reflecting consumer demands.

Preference/acceptability tests have widely been used in both industry and research for other commodities than fish (Lawless and Heymann, 1998), but the tests have not been giving good predictions of consumer behavior (Cardello et al.,

TABLE 3. Consumer QIM for assessment of raw whole non-specific fish species.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Instruction</th>
<th>Description</th>
<th>Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Brightness of skin</td>
<td>Bright</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduced brightness</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dull</td>
<td>2</td>
</tr>
<tr>
<td>Odor</td>
<td>Belly</td>
<td>Sea, Seaweed</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Neutral</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Off odor</td>
<td>2</td>
</tr>
<tr>
<td>Texture</td>
<td>Press with thumb and forefinger along the back of the fish</td>
<td>Firm</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Firm/soft</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Soft</td>
<td>2</td>
</tr>
<tr>
<td>Sum of demerit points</td>
<td></td>
<td></td>
<td>0-6</td>
</tr>
</tbody>
</table>
Preference is often used as a synonym for liking. Liking is one of the extrinsic quality cues, but is only one of many contributors in expected and perceived quality. It is often a surprise and a disappointment when the result of a preference test fails to predict actual consumer preference in a purchase situation. Mela (2000) gives a very illustrative example: the sensory analyst in research and development may find that most people prefer (like better) lobster to canned tuna, but the market researcher knows that the same people clearly prefer (or buy) canned tuna to lobster measured in frequency and volume bought. The process by which consumers become motivated to buy food can be analyzed by looking at the relationship between product characteristics, quality dimensions and purchase motives (Grunert, 1995) using different kind of interview techniques: laddering and means-end (Grunert and Grunert, 1995; Bredahl and Grunert, 1997), repertory grid (Jack et al., 1994), and focus groups (Bisogni et al., 1986). Product characteristics are concrete attributes of the product as perceived by the consumer. Purchase motives are abstract entities, which motivate consumers. Quality dimensions are product specific characterizations of the product on which consumers form the expectation of quality. Example: consumers are interested in the form and color of the fish (intrinsic product characteristics) because they believe it is related to a good taste (quality dimension), which will lead to an enjoyable meal (purchase motive). Quality dimensions include all the extrinsic parameters of the fish; catch area, safety, process-related parameters, brand, etc.

To use this information in a decision oriented way Grunert et al. (1996) suggest a model—the Total Food Quality Model (TFQ) of the relationship between subjective and objective quality (Figure 4). This model, which includes intrinsic and extrinsic quality cues (Figure 1), expected and experienced quality and the quality formation process has been simplified by Bech et al. (2000) and used successfully in optimizing the pea production in Denmark. It will be very valuable for the understanding of the quality ‘logistic’ in the fish industry and for the use of sensory analysis to construct a similar model for each link in the chain and an over-all model.

CONCLUSION

Sensory analysis plays an important role in quality control (Munoz et al., 1992) and quality assurance in the fish sector. To a certain extent sensory analysis has also been used in product development and optimization. There has, however, up until now been very little integration between the descriptive/discriminative analysis and marketing test. Sensory analysis has mostly described the intrinsic product qualities while consumer choice is based both on intrinsic and extrinsic qualities.
The QIM concept can be applied in many parts of the chain from catch to consumer. The limits are that only the intrinsic quality cues are considered in QIM (or other descriptive and discriminative sensory methods). If a more global approach is needed that also involves the extrinsic quality cues, it is necessary to create a Total Food Model (Grunert et al., 1996) for fish, which contains both objective and subjective quality cues. The model should not only consider the consumer perspective but should also include perceived quality in the different parts of the chain. In this way it will be possible to recommend the appropriate sensor method for quality measurement in a specific link of the chain. The multiple perspective of such a model can be made usable with the help of multivariate statistics (Bech et al., 2000).

Returning to ‘eating quality’: given all these considerations, can we answer the consumers wish for fish with good ‘eating quality’? Yes, as far as the experienced quality among other things build on objective measurements of the intrinsic quality. If the consumer feels safe and the perceived quality is equal to the expected quality, the eating situation is pure enjoyment. Pleasure is central to eat-
ing (Hetherington and Rolls, 1996). The pleasure of eating and the pleasantness of foods are established through innate and learned mechanisms. The change in pleasantness as a function of eating is adaptive and contributes to normal eating behavior.

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