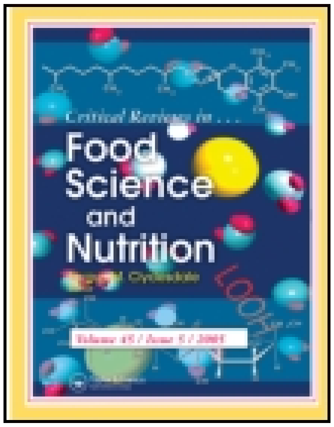

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A Model for Communication of Sensory Quality in the Seafood Processing Chain

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Sensory quality has a key influence of consumer perception of a product. It is therefore of great importance for the processing industry that the sensory quality fulfils the expectations of the consumer. Sensory evaluations are the ultimate tool to measure and communicate sensory quality, but it is generally not fully implemented in the chain from catch to consumer. The importance of communicating sensory demands and results from evaluations in the seafood processing chain is described and a Seafood Sensory Quality Model (SSQM) is suggested as a communication tool.

Keywords seafood, sensory, quality, model, fish, processing

INTRODUCTION

Quality is a multidimensional and complex concept since many different parameters have effects on product quality (Bremner, 2000). The quality of food can be defined as the degree to which a product meets certain needs under specified conditions. The definition depends on the particular context where it is applied, and with differences in the concept of quality confusion can arise mostly due to the combined qualitative and quantitative dimension of quality (Grunert, 2005). Consumer perception of food is in its nature subjective, but in the communication in the food chain between researchers, industry, and retailers a common view of an objective definition is necessary. The correlation and translation between the subjective and the objective understanding of quality is at the core of the economical importance in the production chain (Grunert, 2005). The product is competitive only when the producers have an understanding of the consumer perception.

Many factors influence the perception of food quality as described in the Total Food Quality Model, introduced by Grunert et al. (1996). The model includes the importance of health, convenience, and processing but the importance of sensory quality is also emphasized. However, managing sensory quality of food products is complex, since it is affected by various factors. In the following fish is used as a food model (Fig. 1). In relation to fish some factors are connected to the living fish for example, genetics, age, seasons, and growing conditions. On top of that catching methods, handling after catch, method of slaughtering, processing, storage, and transport are important. The steps from catching or slaughtering until consumption are referred to as the seafood processing chain. In all the steps in the chain, time and temperature are very important for sensory quality. Time and temperature correlate to the loss of freshness, which is of major importance for the sensory quality (Nielsen et al., 1997; Olafsdottir et al., 1997; Peary et al., 1994). The different steps take place in different locations as fishing vessels, aquaculture ponds and pens, slaughterhouses, different means of transport, processing industry, fishmongers, supermarkets, catering businesses, and homes of consumers (Hyldig et al. 2007; Hyldig 2007). All these steps might have a different concept of sensory quality. The importance of a good management practice of sensory quality increases with increasing number of steps and partners in the seafood processing chain.

Sensory analyses are already used in many of the steps in the chain. The partners in the chain generally believe that they deliver a quality, which satisfies the next partner in the chain; but the terms of sensory quality are seldom used in a systematic way. Additionally, the results from the evaluations are normally not recorded or shared between the different steps. Furthermore, most of the participants only have little knowledge about the sensory quality demands of the consumers (Martinsdóttir et al., 2008).

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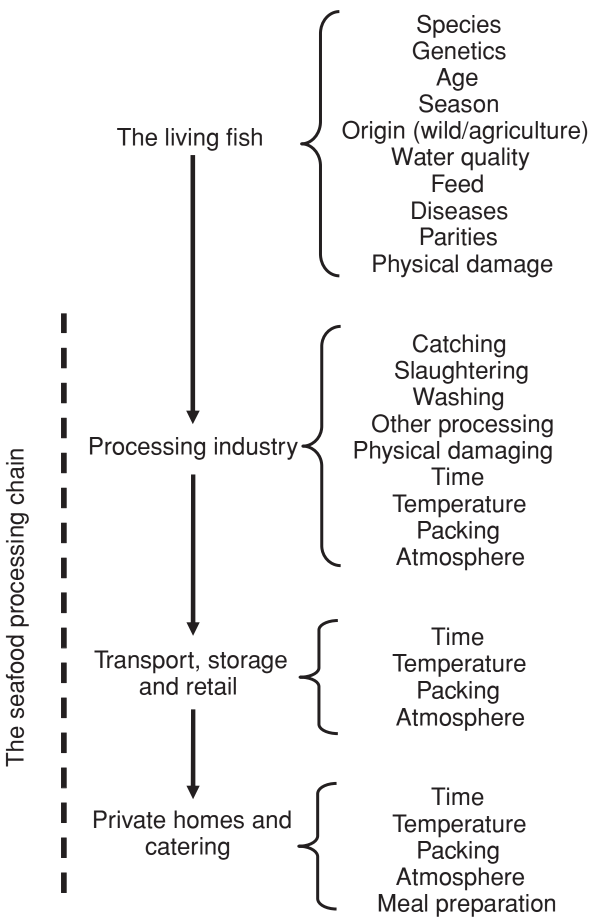

Figure 1 Overview of different factors, which can affect the sensory quality in the fish processing chain.

This paper outlines how sensory analysis can be used in the seafood processing chain, and suggests a Seafood Sensory Quality Model (SSQM) to be used for communication between the partners in the chain. The vision of SSQM is as a general tool that can be used to manage quality in the total chain.

SENSORY EVALUATIONS IN THE SEAFOOD PROCESSING CHAIN

To understand the SSQM it is necessary to understand which sensory methods are relevant to be used in the seafood processing chain; and to go into details of where and how the methods can be used in the different steps in the chain. The choice of method depends on a number of different factors including the reason of performing the sensory evaluations. An overview of important factors of relevance for the sensory evaluations in the seafood processing chain can be seen in Table 1. The table includes references to Fig. 2 which shows an example for a typical seafood processing chain, including suggestions for where it can be relevant to perform sensory evaluations (test points).

The value of the SSQM depends on the reliability of the sensory evaluation performed in each step of the seafood

Table 1 Important factors relevant to measure in the seafood processing chain

Purpose	Test point from Figure 2[1]
Freshness	3, 4, 7, 9, and 10
Species	1,3, and 4
Physical damage of the fish	1, 3, and 4
Fish illness	1, 3, and 4
Presence of foreign matter	2, 3, 4, 6, 7, 9, and 10
Presence of parasites	5, 6, and 7
Presence of bones	6, 7, 9, and 10
Amount of ice	2, 3, and 4
Quality of bleeding	2, 3, and 4
Quality of gutting	2, 3, and 4
Quality of washing	2, 3, and 4
Quality of packing	4, 6, 7, 9, and 10
Quality of filleting	6 and 7
Presence of gaping	5, 6, and 7
Color and homogeneous	5, 6, 7, 9, and 10
General appearance	7, 9, and 10
Presence of off-odors	7, 9, and 10
General odor	7, 9, and 10
Texture	4, 7, 9, and 10
Taste	7, 9, and 10
Quality of other ingredients	8

[1]Shows references to were the different sensory test purposes can be relevant in the example of a seafood processing chain from Fig. 2.

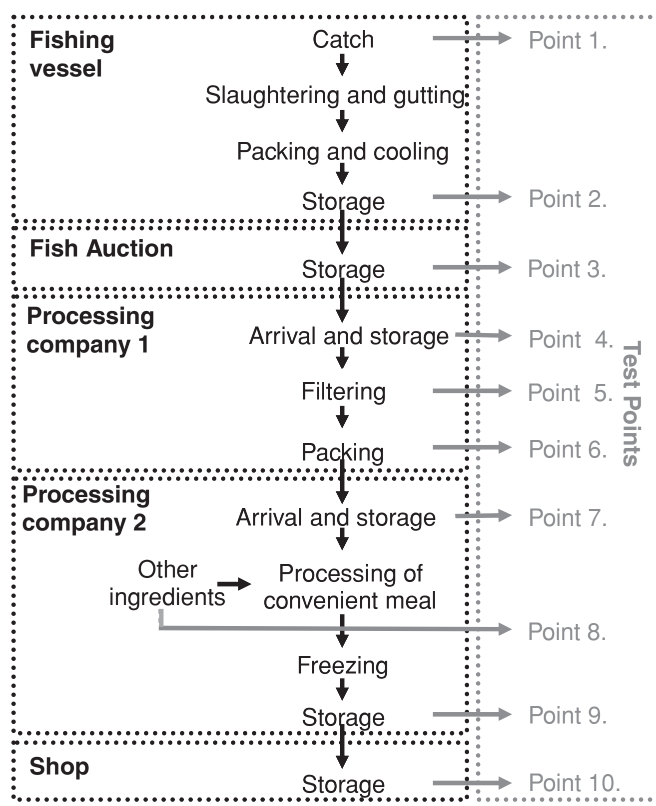

Figure 2 Example of a realistic seafood processing chain. The example includes suggestions of sensory quality test points. Steps of transport between the different companies in the processing chain is not shown.

processing chain. Demands to sensory quality need to be defined, the most appropriate methods must be used in evaluations, and sensory evaluations should be performed according to standards as for example, the guidelines for sensory test (NMKL Procedure No 21, 2008; ISO standards 8586-1, 1993; ISO standards 8589, 1988).

The sensory evaluations can be performed as visual inspection, measurement of odor, texture, and taste. Visual inspection can be performed on whole fish and raw or heat treated fillets. Chance in freshness influence the appearance of fish and visual inspection can therefore be part of freshness evaluation. Visual inspection can also be used to detect other characteristics as fish species, physical damage, and the presence of some diseases in the fish. Physical damage can cause a fast reduction in shelf-life. Furthermore, it can influence the appearance of the final product (Hyldig et al., 2007). Another purpose of visual inspection can be to check the product for foreign matter not wanted in the product. This can be sand, seaweed, packing material, bones, or parasites. Also, the quality of washing, packing, gutting, bleeding, and filleting as well as the amount of ice packed with fish can be inspected with visual tests. Additionally, flesh color, gaping, and homogeneity of the flesh can be tested with visual inspection of both raw and cooked fish. In total there are many different objects of visual testing that are relevant for inspection in the seafood processing chain. Visual inspection can be relevant to perform in all the showed test points in relation to Fig. 2.

Another type of sensory assessment is evaluation of odor, which again can be performed on both raw and heat treated samples, while evaluation of taste is done on heat treated products or products preserved in another way, like sushi and marinated fish. In the seafood industry, sensory tests of the taste are normally performed on a company's final product (Martinsdóttir et al., 2008). Odor and taste evaluation of seafood can be made as part of a freshness evaluation, for instance by checking for the presence of rancid odor and flavor. Odor and taste evaluations can also be performed to check off-odors, for example, muddy or earthy odors (Howgate, 2004) or spices in manufactured products.

Texture can also be measured on both raw and cooked samples, and texture evaluations can be part of a freshness evaluation since for example, firmness of the fish flesh is reduced during storage in ice (Sveinsdottir et. al, 2002). Other aspects of texture which can be of interest are juiciness and toughness of the cooked fillets.

Different sensory methods can be used in the sensory evaluations. It is important that the methods used have sufficient precision in measuring a given characteristic (Costell, 2002). Additionally, the methods usually need to be fast both to perform and in the subsequent data analysis. The most suitable methods are generally descriptive tests and quality ratings, which make it possible to measure the degree of the variation between the product and the demands to sensory quality. In some cases in/out methods can be recommended (Munoz et al., 1992).

In descriptive tests the intensity of a single sensory parameter is evaluated on a scale (Lawless and Heymann, 1998). The result from the descriptive tests needs to be translated into different quality levels. The main advantages of using descriptive tests in a production chain are that the result gives a complete picture of the characteristics and their intensity. The disadvantages of descriptive tests are that they are relatively time demanding in training of the assessors and in data treatment (Munoz et al., 1992).

In quality rating, characteristics are also evaluated on scales. However, these scales are quality scales with end points such as "very poor quality" and "excellent quality." Quality rating has some disadvantages compared to descriptive tests as descriptive tests give the intensity of every single attribute. This means that more detailed data can be established from descriptive tests. Additionally, quality rating also demands a longer training program for the assessors compared to the descriptive test (Munoz et al., 1992), since it is important that the assessors understand the different quality levels.

Descriptive test and quality rating can both be used for many different purposes in relation to the seafood processing chain. This includes determination of freshness, appearance (including color and homogeneity), odor (including off-odors), taste, and texture (Table 1). Descriptive test and quality rating are therefore relevant methods in most of the test point shown in Fig. 2 (test point 2 to 4 and 6 to 10).

In in/out methods the assessors decide whether the product is within or outside a given standard. Assessors also need to be trained in using the standards; however, the training is not as extensive as for descriptive methods. Another advantage is that the results are known instantly. In/out methods can be used if a simple classification of the samples is satisfactory (Munoz et al., 1992). The in/out method is especially relevant in relation to on-line evaluations (test points 1 and 5 in Fig. 2). For instance in/out methods can be used in evaluation of appearance, physical damage, fish diseases, unwanted substances, parasites, bones, amount of ice in the box, gaping, and quality of gutting, washing, packing, and filleting.

As described, the measurement of fish freshness is important in the seafood processing chain. In the example from Fig. 2, it is relevant to measure freshness in test point 3, 4, 7, 9, and 10. Specific sensory methods including the EU scheme (Anon., 1996), Quality Index Method (QIM) (Bremner, 1985; Hyldig and Green-Petersen 2004), and the Torry scale (Howgate et al., 1992) have been developed for the evaluation of freshness of fish.

COMMUNICATION IN THE SEAFOOD PROCESSING CHAIN

An overall problem in the seafood processing is that results from the sensory evaluations in a single step of the chain are often unavailable to the other partners in the chain. This is a setback since the results generally are relevant not only for the partner performing the evaluations, but also for the other partners. Examples demonstrating the value of sharing sensory quality information in the seafood processing chain are shown in the following.

Example 1: A Company Producing Fish Fillets

Processing company number one in Fig. 2 buys raw material (fish) from a fish auction and stores the fish until filleting and packing—the packed filets being the end product. The company measures freshness by using the sensory evaluations of the raw material (test point 4 in Fig. 2). The company can use the measured freshness first of all by deciding if the freshness is acceptable and therefore can use of the raw material in the production. Furthermore, the results can be used to determine how long the fish can be stored before production and also to establish the self-life of the final product of the companies. The measured freshness gives additionally the company documentation for the fish quality, which can be used in relation to the other partners in the chain.

For the partners earlier in the chain, the fishing vessel, and the auction (Fig. 2), the results are of high relevance because they contain information about the quality of the product from the fishing vessel and the auction, and the information can be used for optimizing the handling of the fish. Furthermore, the processing company one can use the results to determine what they are willing to pay for the raw material.

The partners later in the chain can also benefit from the information of the results from the sensory freshness evaluation performed in test point 4, since freshness here has significant influence on freshness later in the chain. First of all the product must have a freshness which will satisfy the processing company two for their production. Secondly, the processing company two might use the freshness evaluation results from test point 4 to predict the shelf-life of their own products. Additionally, if the processing company two has the results from test point 4, they might be able to reduce the extent of sensory testing performed on their raw material and/or final product (point 7 and 9)—again this demand that a systematic model for sharing of information is used.

Sharing of information in the chain requires, however, an accepted communication tool.

As illustrated in the example, communication of sensory quality is an advantage both for the partner performing the sensory testing and for partners earlier and later in the processing chain. Moreover, communication of sensory quality can be used for optimizing the production in the different steps of the chain. Communication is also valuable in relation to determination of the optimal way of performing sensory evaluations. First of all, as illustrated in the example above, communication can reduce the amount of sensory evaluations to be performed. Secondly, communication and relation of quality between the different test points can be used for evaluation of the relevant measurements. According to Munoz et al. (1992) there are two major factors that determine which sensory characteristics should be evaluated, 1) the sensory characteristics must show a variation, 2) the sensory characteristics must affect consumer attitude towards the product.

The following example shows how communication and relation of sensory quality between different test points can be used to determine which sensory characteristics should be measured in the different test points.

Example 2: A Company Producing Frozen Convenient Meals

The processing company two from the seafood processing chain in Fig. 2 is buying packed filets from processing company one to produce frozen convenient meals. Processing company two might have a considerable variation in the sensory quality of the raw material (measure in test point 7). The quality can vary according to the filleting quality and color. In order to determine which sensory characteristics are going to be measured in test point 7, company two needs first to investigate the relationship between the quality in test point 7 and 9 by making descriptive sensory measurements at both points. If the results show that both the quality of filleting and color in point 7 has influence on the appearance of the product in point 9, the company needs to find out how this variation affects the consumers. This should preferably be done by performing a consumer test, which includes samples representing the different appearances caused by the variation in the quality of filleting and color. If the consumer test shows that filleting has a considerable influence on consumer acceptability, while the variation in color has no effect, it is clear that it would be beneficial for processing company two to define quality demands of the filleting in test point 7 and perform sensory tests here. Furthermore, processing company two should inform processing company one about the demands to filleting quality and the results from the evaluations performed in test point 7.

The results from the consumer test, regarding the non-existing influence of color on the consumer acceptability of the products, does not necessarily implicate anything about the relevance of defining sensory standards and measurement of color in test point 7. This is due to the fact that the variation in color might influence the confidence of the consumers and thereby the reliability of the product (Stone and Sidel, 1993).

Again, the sharing of information in the chain requires an accepted communication tool.

THE SEAFOOD SENSORY QUALITY MODEL (SSQM)

To establish communication of sensory quality in the seafood processing chain the SSQM (Fig. 3) is suggested. The SSQM can be used to communicate the sensory quality of seafood, and make it possible to share the understanding of the sensory quality. The SSQM makes it achievable to document sensory quality in different test points and to relate it to every step in the chain. Not only results from sensory evaluation, but also other information with an effect on the sensory quality can be included. Additionally, the SSQM is valuable in relation to deciding which sensory characteristics should be measured in the different test point in relation to product decision and product development.

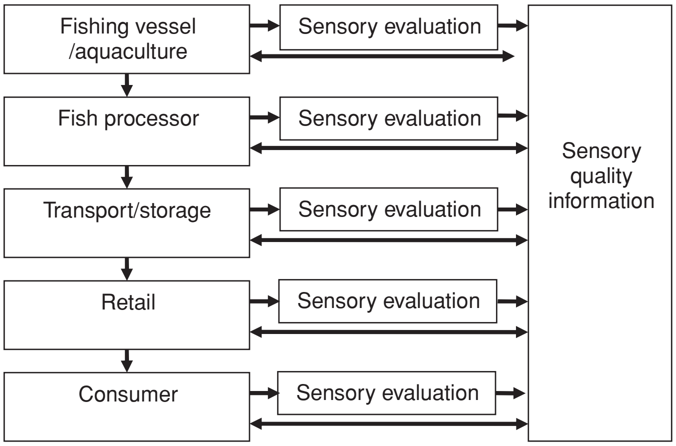

Figure 3 Illustration of the Seafood Sensory Quality Model (SSQM).

Figure 3 illustrates the SSQM with the different steps from the vessel/aquaculture to the consumer and shows the information flow used for the communication within the processing chain and the surrounding companies. The SSQM can be used for communicating demands and results from sensory evaluations and for communicating other characteristics which can influence the sensory quality as microbiological, physical, and biochemical characteristics (Refsgaard et al., 1998; Sveinsdottir et al., 2003, Robb et al., 2002) together with time and temperature information.

As far as possible, the SSQM should be easy to use. It implies that the sensory quality information after being registered automatically must be passed on to the relevant partners in the chain. Using the internet for this information flow is an obvious possibility. The system could function in parallel with systems used for traceability.

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