

METHODS OF QUALITY ASSESSMENT OF FISH

INTRODUCTION

Quality assessment is a part of quality assurance that focuses on assessment of fulfilling quality requirements. The quality of fish and fishery products has become a major concern in fish industry all over the world. Fish, being one of the exceptionally perishable foods and as a result of globalization of food trade fish products tend to be more susceptible to rejection due to poor quality especially if the initial raw materials are of poor quality despite the technological developments in fish production. Furthermore, various outbreaks of food-borne illnesses, among which fish has been implicated as one of the vehicle foods, in various countries in the past years have led to strict food quality/safety rules and regulatory system worldwide. Most often "quality" refers to the aesthetic appearance and freshness or degree of spoilage which the fish has undergone.. To maximize the value of the fishes, freshness quality must be maintained. To increase the acceptability of the fish product, the method of quality assessment must be known. Essentially, the objective of fish and fish product assessment is to avoid the ingestion of contaminated food; to evaluate the nutritive value of food by detecting the presence of biological, chemical and physical hazards and in the end to ensure the safety of the consumer. To assess the safety of fish and fish products both instrumental and sensory methods are used. Sensory methods are the most satisfactory way of assessing the spoilage and freshness of fish and fishery products.

IMPORTANCE OF QUALITY ASSESSMENT OF FISH

The word quality is an aesthetic concept which means the 'totality of characteristics of a recently harvested product that bear on its ability to meet stated or implied requirements. Although being one of the most vulnerable and perishable products, fish and other seafoods provide a wide range of health-promoting compounds. Recently, the growing interest of consumers in food quality and safety issues has contributed to the increasing demand for sensitive and rapid analytical technologies. Several traditional physicochemical, textural, sensory, and electrical methods have been used to evaluate freshness and authentication of fish and other seafood products. The objective of quality assessment of fish is to assist the maintenance or improvement of profitability by minimizing customer complaints about quality, and hence to avoid the resulting lost business. Customer complaints mainly arise because quality has fallen; therefore the objective of quality assessment is realized by keeping quality of output at the right level. Loss of profitability can also occur when fish products do not comply with local or national regulations. Quality assessment can give protection here also. Maintenance of quality is particularly important for branded products, because a brand name becomes associated with a particular quality level, and any lowering of the level causes the customer to lose confidence in the brand; sales of other goods under the same brand may then also be reduced.

OBJECTIVES

- To identify the methods for evaluation of fish quality
- To determine their application in fish industry
- To know better quality evaluation or assessment techniques in fish

QUALITY ATTRIBUTES OF WET FISH

Products with quality attributes must ensure safety for consumers through formal systems, such as certification, origin identification, and traceability of production processes. However, consumers are more demanding in terms of their choices, and issues related to food quality are at the forefront regarding consumers' concerns, industry strategies, and in some cases, government policies.. Such initiatives should be encouraged considering that fish consumption is associated to health issues, which are the main attributes of interest for consumers. One of the key factors associated to fish consumption is the people's recent interest in health, longevity, and food safety.



Figure 01: Characteristics quality of wet fish and component authorities to safeguard consumers' interests

Such behavior has increased fish consumption patterns and the demand for products with special characteristics that influence consumers. Again the freshness of the fish depends on its appearance, odor, flavor, palatability etc.

METHODS OF QUALITY ASSESSMENT OF FISH

The methods for evaluation of fresh fish quality may be conveniently divided into two categories. They are:

- Sensory method of quality assessment
- Non-sensory or instrumental method of quality assessment

SENSORY METHOD

Sensory evaluation is one of the most important methods for assessing freshness and quality in the fishing sector and in fish-inspection services. Sensory methods performed in a proper way are a rapid and accurate tool providing unique information about the food. Considering all the developments in instrumental methods that have occurred in the last decade, sensory methods remain the most satisfactory way of assessing the freshness of fish and fishery products. Objective seafood sensory tests, based on certain attribute of raw fish (skin, eyes, gills, texture, etc.), are the most commonly used methods for quality assessment of raw whole fish in the inspection service and fishing industry. Sensory evaluation of food is defined as the scientific means of quantifying and interpreting the variations in food characteristics (odour, taste, tactile, appearance) by using human senses of sight, smell, taste, touch and hearing. Studies have shown that assessment of food freshness/ characteristics using sensory methods are capable of giving objective and/reliable results when assessments are done under controlled conditions. They can be very fast, reliable, non-destructive on raw fish and no expensive instruments are needed.. There are several grading methods used to assess freshness in fish and fish products such as:

- a) The European Union scheme
- b) The quality index method
- c) The torry scoring system

(a) European Union scheme

The EU scheme its main advantage is that it is specific for each species and the fluctuation between assessors is diminished. There is, however, still some discrepancy as the scheme does not take account of differences between species into account as it only uses general parameters. A suggestion for renewal of the EU scheme can be seen in Multilingual Guide to EU Freshness Grades for Fishery Products; where special schemes for whitefish, dogfish, herring and mackerel are developed .It is widely used in European countries.

In this scheme, three grades of freshness are established: E, A and B, corresponding to various stages of spoilage. E (Extra) is the highest possible quality, while below B is the level where fish is considered unfit for human consumption. The criteria of EU scheme for different species such as whitefish, redfish, anglerfish, pollocks, flounder, scabbard fishes are given below in the table:

	CRITERIA			
	Freshness Category			Not Admitted
	Extra	A	B	
Skin	Bright, iridescent pigment or opalescent ,no discolouration	Pigmentation bright but not lustrous	Pigmentation in the process of becoming discoloured and dull	Dull pigmentation
Skin mucus	Aqueous, transparent	Slightly cloudy	Milky	Yellowish, grey, Opaque mucus
Eyes	Convex, black, bright pupil, transparent cornea	Convex and slightly sunken, black, dull pupil	Flat, opalescent cornea, opaque pupil	Concave in the centre ,grey pupil, milky cornea
Gills	Bright colour, no mucous	Less coloured, transparent mucus	Brown/green becoming discoloured, thick opaque mucus	Yellowish, milky mucus
Peritoneum on gutted fish	Smooth, bright, difficult to detach from flesh	Slightly dull, can be detached from flesh	Speckled, comes away from flesh	Does not stick
Smell of gills and abdominal activity	Seaweed smell	No smell of seaweed, neutral Smell	Fermented ,slightly sour	Sour
Flesh	Firm and elastic, smooth surface	Less elastic	Slightly soft, less elastic	Soft, scales easily detached from skin, surface rather wrinkled

Table 01 : Criteria of EU scheme

This method gives rather limited information about the condition of the fish, as it is not species-related and does not therefore take into account the differences between species. The EU-scheme is commonly accepted at auction levels however its use has been disputed.

Quality Index Method (QIM)

It is critical for a sensory system used in quality management that it reflects the different quality levels in a simple and documented way. Therefore, new and improved seafood

freshness and quality grading systems that are both rapid and objective have been under development for various species. The Quality Index Method (QIM) is one such system and has several unique characteristics. QIM is based upon a scheme originally developed by the Tasmanian Food Research Unit in Australia. The method is based on characteristic changes that occur in raw fish. These relate to the outer appearance attributes of the eyes, skin, gills and odour and a score system from 0 to 3 demerit (index) points.

Quality Index Method (QIM) Scheme for Farmed Salmon

Quality parameter		Description	Score
Skin	Colour/ appearance	Pearl-shiny all over the skin	0
		The skin is less pearl-shiny	1
		The fish is yellowish, mainly near the abdomen	2
	Mucus	Clear, not clotted	0
		Milky, clotted	1
		Yellow and clotted	2
	Odour	Fresh seaweedy, nutral	0
		Cucumber, metal, hay	1
		Sour, dish cloth	2
		Rotten	3
	Texture	In rigor	0
		Finger mark disappears rapidly	1
Finger leaves mark over 3 seconds		2	
Eyes	Pupils	Clear and black, metal shiny	0
		Dark grey	1
		Matt, grey	2
	Form	Convex	0
		Flat	1
Sunken		2	
Gills	Colour	Red/dark brown	0
		Pale red, pink/light brown	1
		Grey-brown, brown, grey, green	2
	Mucus	Transparent	0
		Milky, clotted	1
		Brown, clotted	2
	Odour	Fresh, seaweed	0
		Metal, cucumber	1
		Sour, mouldy	2
Rotten		3	
Abdomen	Blood in abdomen	Blood red/not present	0
		Blood more brown, yellowish	1
	Odour	Neutral	0
		Cucumber, melon	1
		Sour, fermenting	2
	Rotten/rotten cabbage	3	
Quality Index			0-24

Figure 2 : An example (Farmed salmon) of quality index method

The scores for all of the characteristics are summarised to give an overall sensory score, the so-called Quality Index. QIM has to be adapted to each fish species.

The scientific development of QIM for various species aims at having the Quality Index increase linearly with the storage time in ice. QIM has several advantages, including

estimation of past and remaining storage time in ice. The descriptions of each score for each parameter are listed in the QIM scheme.



Figure 03: Quality index method

The assessor must evaluate all the parameters involved in the scheme. As the Quality Index increases linearly with storage time in ice, the information is well suited to use in production management. QIM is well suited to teach inexperienced people to evaluate fish, train panellists and monitor performance of panellists. The scores for all the attributes are then added to give an overall sensory score, the so-called quality index. The quality index increases linearly with keeping time in ice. Therefore the total demerit score can also be used to predict the remaining shelf life. The description of the evaluation of each parameter is written in a guideline. No excessive emphasis is laid on a single attribute so a sample cannot be rejected on the basis of a single criterion. Minor differences in results for any one criterion do not unduly influence the total QIM score. The lower the score, the fresher the fish.

The torry scoring system

Torry Freshness Score is a systematic scoring system, originated in UK, based on objective sensory scoring method (tester(s) will smell the fish gill odour) to assess the state of fish or the fish freshness.. It is done on both raw and cooked (without ingredients) fashion, and the criteria are generally fish species specific. The results of evaluation generally correlate to (density of) presence of microorganisms that cause spoilage, as lower score implies more presence of microorganisms. It relies on human sensory perception as the input, although recently they develop electronic tools to validate the job. Generally it is important and relevant in the daily activities in fish marketing.

The scoring system starts with 10 and declining. Ten (10) is the highest score for newly caught fish, 7 is in the neutral range, 6 is at the 'borderline', and 3 or lower score is considered spoiled. Customers generally reject them when it is down at the 6 score or lower.

Torry score of 6 (11 days on ice) is considered the cut off point for sale, as it is the point just before off flavours and odours are detected.

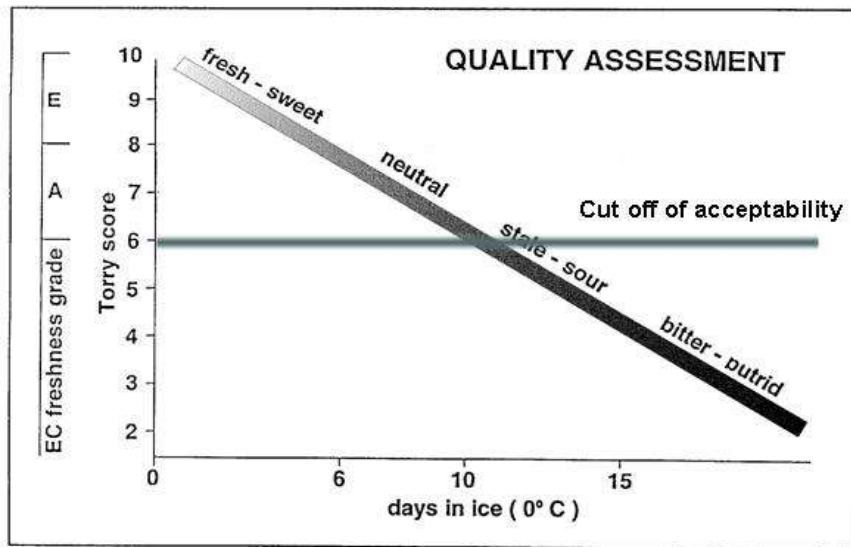


Figure 04 : Torry scores and quality changes in chilled fish

The most used scale for evaluating the freshness of cooked fish is the Torry-scores. The Torry-scores method explaining the freshness of the cooked fish and score sheets for assessment of cooked odours and flavours of iced lean fish. Quality deterioration of fish is first characterised by the initial loss of the fresh fish flavour (sweet, seaweedy) which is followed by the development of a neutral odour/flavour .

Cooked Odour	Types of Flavour	Score Torry score
Fresh seaweed, sweet, fresh milk, faint iodine, fresh, tangy, lemons	Fresh meaty, sweet, watery, spicy-lemons, metallic	10
Melting margarine, spicy, shellfish, green plant type odour	Loss of fresh meatiness and metallicness, nutty	9
Bready-yeasty, boiling milk, woody	Sweet, neutral, slightly meaty	8
Caramel, sweet fruity-malty	Very slightly sweet, slight cardboard, creamy	7
Fatty, sweet/sour	Sweet/sour, onions, lemons, fatty	6

Figure 05 : Torry scoring system

End of shelf life is usually determined when sensory attributes related to spoilage such as sour, pungent, TMA odour and/or flavour become evident

NON SENSORY METHOD

Since sensory methods of assessment apply the same senses as the consumer uses when deciding whether a piece of fish is pleasant to eat, they are likely to predict the consumer's reaction better than non-sensory methods; the latter do, however, have certain advantages. Since sensory assessment may require the use of a taste panel, non-sensory methods can be cheaper and often quicker. Taste panels need to be trained and kept in training, which can be time-consuming. Non-sensory assessments should give the same result no matter where they are carried out, whereas sensory evaluations may depend on subjective responses of the panellists to the fish being examined. Non-sensory methods can appear more objective and reliable than sensory methods, although this need not be the case. When specifications are being prepared it is easier to insert numerical limits based on non-sensory tests than on sensory tests, especially in international trade, and this is widely done. Courts of law may find it easier to accept the results of chemical or physical tests, being based on impartial instrumental readings, than the results of sensory tests. There are different kind of non sensory or instrumental method, they are described below:

a. Biochemical methods

A variety of chemical compounds or groups of compounds accumulate post-mortem fish muscles. These chemicals are either intermediate or end products of biochemical changes occurring in the muscles of fish after death.

Proximate composition: Because of influence of chemical composition on keeping quality, proximate chemical composition like moisture, lipid, protein and ash contents of fish samples from the time or day of harvest to different storage periods or conditions are often investigated. Proximate composition may vary with species, sex, season, place of harvest, feeding condition, etc. So, conclusive results are very difficult to obtain.

Hypoxanthin value: As a consequence of post-mortem changes, breakdown of ATP to ADP, AMP, IMP and finally to hypoxanthin takes place. Hypoxanthin content of muscle increases on storage of fish. Estimation of hypoxanthin is an objective test of freshness of fish. However, the estimation of hypoxanthin is too cumbersome and it is seldom employed in practice. Fish with a hypoxanthin value of 7-8 micro moles/g is considered spoiled.

Histamine content: Histamine develops in freshly caught fish after 40-50 hours of death, if the fish is not properly iced. To avoid histamine formation in tuna, skipjack and mackerel, care is taken to ice or freeze fish as quickly as possible. Histamin is a major problem in warm water pelagic species that causes a form of food poisoning known as scombroid poisoning, as the name derived from the family name of tuna and mackerel, scombroidae. The term is also applied to other family members too. The symptoms of scombroid poisoning are facial flushing, rashes, headache and gastro-intestinal disorders.

Histamin is produced from histidine which is one of the constituents of muscle protein of all fishes. Generally, pelagic fishes contain sizable amount of histidine in free state as well as bound state within protein. Upon death, histidine in fish muscle is converted to histamine by bacterial enzymes. Histamin content over 20mg/100g in canned fish is prohibited by the US-FDA standard.

pH: Change in pH of the fish muscle is an usual good index for freshness assessment.

Trimethylamine: Marine fish contains sizable amount of trimethylamine oxide (TMAO) which is reduced to trimethylamine (TMA) during the spoilage of fish. TMA determination is a useful index to measure the quality of stored fish. Fish with a level of 1.5 mg TMA nitrogen/100 g fish is considered acceptable, while 10-15 mg/100 g limit is set for moderately spoilt fish and beyond this range is set for highly spoilt fish.

Ammonia: Bacteria can generate small amounts of ammonia in spoiling fish, mainly from free amino acids; the amount of ammonia can give an indication, though not a particularly accurate one, of the extent of spoilage. Much larger amounts of ammonia are produced during spoilage of the elasmobranch fishes, skate and dogfish for example, because they have large amounts of urea in their flesh. Shellfish, also, may develop more ammonia than most marine fish and at an earlier stage. There are several chemical and enzymic methods for measuring ammonia.

Peroxide value: Oxidative rancidity developed in fish tissue is determined by the estimation of peroxide value. Good quality fish should have a peroxide value quite less than 10. Peroxide value above 20 for any fish is considered rancid.

Thiobarbituric acid value (TBA): It is also determined as an index of oxidative rancidity in fish. For a good quality moderate lipid fish, TBA value of less than 2 is usually accepted.

K value: High level of adenosine related compounds or inosine mono phosphate in fish muscle imparts sweet, meaty flavour and is regarded as a reliable index of freshness. Post-mortem accumulation of inosine or hypoxanthin generally reflects poor quality. The conversion of ATP to IMP is very fast and is usually complete within a day. Subsequent accumulation of inosine or hypoxanthin is related to both autolytic and microbial action. Based on hypoxanthin values and their correlation with freshness of fish, Saito et al first proposed the K value as an index of the freshness of fish. K value is calculated from the values of hypoxanthin, inosine and total nucleotide levels in fish at the point of measurement as shown in the equation (i). However in practical situation adenosine compounds are deleted because of their conversion into IMP, HxR and Hx, shown in equation (ii). In freshly caught fish K value would be as low as zero, in moderate quality fish the value could be 10 to 20, but in spoilt fish it can go upto 90. K values are found to have excellent agreement with sensory data of fish. K values also rise with the ice storage period of fish.

$$\text{K Value} = \frac{\text{HxR} + \text{Hx}}{\text{ATP} + \text{ADP} + \text{AMP} + \text{IMP} + \text{HxR} + \text{Hx}} \times 100 (\%) \text{ (Theoretical)} \dots\dots\dots (i)$$

$$\text{K Value} = \frac{\text{HxR} + \text{Hx}}{\text{IMP} + \text{HxR} + \text{Hx}} \times 100 (\%) \text{ (Practical)} \dots\dots\dots (ii)$$

b. Biological method

Total plate count (TPC): Total number of microbial flora is changed with the time in fish or fish products. The numbers per gram of fish or fish products or per square centimeter of the surface area indicate the quality of fish from the microbiological view point. Total plate count or viable bacterial count is determined by the culture of bacteria present in fish sample using a suitable bacteriological media that could recover maximum number of bacteria in fish tissue. A known weight of fish sample is minced aseptically and serial decimal dilutions are pour-plated with the media. For marine fish agar agar and for processed fish products tryptone glucose beef extract agar media are commonly used. Inoculated plates are incubated at 37°C for 24 hours and the bacterial colonies are counted. From the colony counts, TPC is calculated by multiplying with appropriate dilution factor. TPC does not strictly indicate the edibility of the fish. Fish with low TPC may bear pathogen that would have more dangerous if consumed. Therefore, qualitative analysis is done to determine the presence of any pathogenic or health hazard bacteria. Different types of selective or ordinary media are used for the identification of pathogenic organisms in fish. For example, SS-agar or XLD agar medium are used to detect coliform bacteria like *Salmonella*, *Shigella*, *E. coli*

c. Physical methods

The electrical properties of fish skin and muscle change systematically after death and can be used as the basis of an instrument; a few models are commercially available, including the Torrymeter.



Figure 05 : Physical method

The change in electrical properties is not caused directly by bacterial action or other spoilage mechanism, but the instrumental readings on iced fish can be correlated with the stage of spoilage, as measured by sensory methods or by one of the non-sensory methods already described. The instruments can be used only on whole fish or fillets with skin. Frozen fish, when thawed, give no response to the meter and this can be used as a basis for checking whether fish have been previously frozen.

ORGANOLEPTIC METHOD

Sensory methods are used to assess the degree of freshness based on organoleptic characteristics such as general consistency of flesh, odour, color, eye and gill condition etc. These characteristics are judged by panel members. i.e. subjective judgment are made by individuals. Various numerical scoring or ranking systems have been developed to evaluate the judgments or results. Sensory methods have advantages that it can be adapted by the human being easily and the quality can be assessed by odour or visual inspection for quality defects. Human senses indeed are more efficient in some complex tasks than the instruments. The method is described more in chapter 16. There is, however, no single satisfactory test developed for the quality assessment of fish. A combination of chemical, biological and organoleptic tests would be the best procedure to assess such freshness.

CONCLUSION

The quality assessment of fish and other seafood is hampered by the immense variation between species and by the considerable variability between specimens of each species. The challenge when assessing aquatic animals is that immediately after capture or harvest an alteration in intrinsic properties is initiated firstly by metabolic (autolytic) and secondly by microbiological processes which last until the final state of spoilage is reached. This chapter discusses several analytical methods (chemical, physical, microbiological and sensory) that can be used to determine spoilage depending on its state. The preferred instrumental method for the determination of quality of seafood should ideally be cheap, easily handled and operated by non-scientifically educated personnel, non-invasive and non-destructive, able to measure freshness and spoilage throughout the whole span from catch/harvest to spoilage, used for all species and all types of seafood. Considering the increase in the demand for information about the quality and freshness by the consumers and growth of e-commerce, quality assessment method appears to be an efficient tool to assess the storage history and estimate the remaining shelf-life of the fish. The implementation of this standardized method for all the key stages of fishes chain for evaluating the quality freshness of the fishes would help the industry supply safe, high-quality and health promoting fish-products, giving a unique value to it. The cooperation between the research institutes and industry would be considered essential for developing new schemes for different handling, storage and packaging conditions.

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