Module III  Shelf Life Testing of Foods

Chapter 7 Shelf life of fresh seafood

Objectives: By the end of this module, you will have learnt

a) What are the key causes of quality deterioration in fresh seafood?
b) How is fresh seafood graded for quality?
c) What procedures are useful in extending shelf life of fresh seafood?

Shelf life of seafood is influenced largely by microbial activity. Furthermore, chemical changes are also important in determining the quality of seafood.

Seafood have short shelf life mostly due to the composition of the fish flesh-- its high pH, high free amino acids, presence of TMAO (Trimethylamine oxide),and potential presence of psychotolerant spoilage microflora. Also, fish caught in the wild and from different habitats may have more variable intrinsic characteristics than the consistency observed in other agricultural raw materials.

To understand the shelf life of seafood, the specific spoilage organism (SSO) concept is important (Dalgaard). This concept focuses on the "spoilers" in contrast to "non-spoilers" that do not participate in spoilage. On freshly harvested seafood, SSOs are present in very low concentration (compared with the total microbial count). Depending upon conditions such as temperature, pH, percent NaCl and preservatives, SSOs grow faster than other microorganisms, producing metabolites that cause off-flavors. When a product is rejected by a sensory panel, it is not the total microbial count but the SSOs, often of a single species, that are the main culprits.

The SSO concept allows for objective analysis and prediction of shelf life. For example, by measuring the number of SSOs and the concentration of their metabolites one can determine spoilage on an objective basis. Thus a relationship can be developed between the log numbers of SSOs and the remaining shelf life. Mathematical models based on this concept have been found useful in determining shelf life.
Following are some of the methods used for sensory evaluation of fresh seafood.

7.1 European Union Scheme of Evaluation

Whole and gutted fish are evaluated based on following characteristics:
- appearance
- odor of skin
- outer slime
- eyes
- gills
- peritoneum

Each of the preceding characteristics of the fish is given a grade from 0 (spoiled) to 3 (completely fresh).

An average score (AS) is computed and the fish is then graded as Grade E (for Extra), Grade A, Grade B, and Grade C (unfit for human consumption); where the average scores for each grade are as follows:

- Grade E: AS > 2.7
- Grade A: 2.7 < AS < 2.0
- Grade B: 2.0 < AS < 1.0
- Grade C: AS < 1.0 unfit for human consumption.

While the above scheme is useful for grading purposes, the final grades assessed for a lot do not assist in determining the shelf life. Because the grading system is complicated it is not universally practiced.

7.2 Torry Research Station (Scotland) method

This method developed at the Torry Research Station involves assessment of raw appearance, raw odor, raw texture, cooked color, cooked texture, and cooked flavor. For sensory measurements, four to nine trained assessors are used.

Each quality attribute is scaled by 5 or 10 descriptive terms and corresponding numerical scores. Over the storage period, the numerical score decrease. This change in scores is useful to determine shelf life. Typically, a score between 4 and 6 (when attribute scores range from 0 to 10) signifies the end of shelf life.

The Torry scheme with scores for cooked flavor alone has been used to determine shelf life. A quality attribute (such as cooked flavor) is divided into 2 to 10 descriptive terms and numerical scores are used.

7.3 Danish Institute for Fisheries Research method
A classification and scoring system developed at the Danish Institute for Fisheries Research, Lyngby, Denmark involves three grades, Grade I, II, and III. Grades I and II are acceptable, with no off-odor/flavor (odor/flavor characteristic of species, very fresh, seaweedy) or slight off-odors/flavor (neutral, slight off-odors/flavors such as mousy, garlic, bready, sour, fruity or rancid). Grades I and II have sensory scores decreasing from a high of 10 to 4. Grade III is considered Unacceptable or Reject, it is for product with severe off-odor/flavor (strong off-odors/flavors such as stale cabbage, ammonia, hydrogen sulfide) and low sensory scores of 3 to 1. The grade scores can be used to determine shelf life of the product.

7.4 CSIRO Method using Demerit Point System

The demerit point system was developed at CSIRO, Hobart, Australia. In this method a large number of attributes are evaluated in sequence and each is scored from 0 to 3. The evaluation may be done by an expert or a novice. The sum of all attribute scores increase with storage time and the plots (often linear) may be used for shelf life determination. This is a simple and rapid method for shelf life determination. For these reasons, it has found use in Europe under a new name – Quality Index Method (QIM). QIM is useful for fresh and thawed whole fish.

All the preceding methods rely on sensory measurements that can be expensive and time consuming. Furthermore, consumer testing has shown that sensory methods are not that useful in developing detailed information on various sensory attributes. Instead determining the time to spoilage is more important for consumers.

7.5 Analytical Procedures to determine Shelf life

Microbiological Procedures

Total viable counts (TVC) or aerobic plate count (APC) do not correlate with fish spoilage. Still TVC are used in commercial trade of seafood. A more accurate prediction of fish spoilage is obtained by counting specific spoilage organisms (SSO). Four SSOs, namely, S. putrefaciens, P. phosphoreum, B. thermospacta, and lactic acid bacteria have shown high correlation to remaining shelf life of seafood.

Research on identifying SSOs is needed to improve microbiological procedures of shelf life determination.

Chemical Methods

Metabolite byproducts of microbial organisms are used in determining spoilage.

\[ K \text{ value} = \frac{([\text{Ino}] + [Hx]) \times 100}{([ATP] + [ADP] + [AMP] + [IMP] + [\text{Ino}] + [Hx])} \]
Where: Ino = inosine; Hx = hypoxanthine; ATP = adenosine triphosphate; ADP = adenosine diphosphate; AMP = adenosine monophosphate; IMP = inosine monophosphate

K-value increases in fish during storage. K value of 20% is considered to be a critical value in Japan for consumption as raw fish. In trout and tuna, K-value increases linearly with time.

**Volatile Amines**

Fish spoilage results in production of volatile amines such as trimethylamine (TMA). Therefore TMA is recommended as an indicator of seafood spoilage by Codex Alimentarius. The European Commission recommends use of Total Volatile Nitrogen (TVN) as an indicator if spoilage is indicated by sensory evaluation. TMA production occurs only after the SSOs have sufficiently increased. Both TMA and TVN production are species dependent.

**Biogenic Amines:**

During fish spoilage, there is increased concentration of biogenic amines such as histamine, cadaverine, agmatine, spermidine, and tyramine. A Biogenic amine index has been suggested as a fish spoilage indicator. BAI = (ppm histamine + ppm putrascene + ppm cadaverine + ppm tyrosine) has been used in grading tuna.

**Volatile Sulfur Compounds**

Spoiled fish emits volatile sulfur compounds, e.g 150 ppb hydrogen sulfide in cod measured at the point of rejection. With the use of electronic nose and other improved instruments, it is a promising indicator.

**7.6 Review Question:**

1) What are some of the indicators of spoiled seafood?

2) What is a specific spoilage organism (SSO)?

3) What is a K-value?

**7.7 References and Additional Reading:**