

Shelf Life of Foods (including Food Losses)

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Module I Principles of Shelf Life

Chapter 1: Definition of Shelf Life and Factors that Influence Food Stability

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

- a) What are some of the challenges in defining shelf life?
- b) What factors influence shelf life of foods?
- c) How to define food quality and shelf life?

Today's consumers demand safe foods, consistent quality attributes and minimal changes in sensory quality from the time of purchase to consumption. Food manufacturers must meet these demands and also respond to any regulations on shelf life dating of their products. Therefore an understanding of the food stability during storage is vital. Furthermore to combat food losses during storage and distribution, the knowledge of various causes of food degradation is necessary to develop strategies to minimize food losses.

To determine shelf life, food manufacturers attempt to predict the end point of storage life under assumed storage and distribution conditions. The end point may be based on the following two criteria: 1) Microbiological criteria are based on the number of spoilage or pathogenic microorganisms and their growth pattern. 2) Non-microbiological criteria are more difficult, since they are based on the desired sensory characteristics. On the other hand, criteria related to the chemical composition of the food are somewhat easier to establish. For example the loss of some nutritional component may be measured using routine tests during a certain storage period.

Many foods may stay microbiologically safe, yet their sensory characteristics may change by a wide margin, and may not be tolerated by consumers. The acceptable sensory characteristics of a given food are defined by the company policy. Some have referred to this exercise as "percentage of consumers a manufacturer is willing to displease."

1.1 Challenges in defining shelf life of foods

A definition of shelf life by Institute of Food Technologists (1974) notes that shelf life is "the period between manufacturer and retail purchase of a food product during which the product is of satisfactory quality." The Institute of Food Science and Technology, IFST(1993), suggests that "shelf life is defined as the time during which the product will: a) remain safe, b) be certain to retain desired sensory, chemical, physical and microbiological characteristics, and c) comply

with any label declaration of nutritional data, when stored under the recommended conditions.”

In the above two definitions, “satisfactory quality”, “desired ... characteristics” are highly ambiguous terms that lead to confusion when used in practice. Similarly, “stored under the recommended conditions” does not address thermal abuse of the product in the distribution segment of the food chain. This problem can be addressed if the manufacturer has a complete understanding of the product and how it will deteriorate under different environmental conditions. In most cases, food products tend to be complex and therefore such knowledge is not readily available. The lack of information about the deterioration mechanisms of complex foods with complex structures causes lack of precision in predicting shelf life.

1.2 Factors Influencing Shelf Life of Foods

The shelf life of foods is influenced by two types of factors, intrinsic and extrinsic.

Intrinsic Factors: These factors are due to the composition and properties of the food itself. Some of the major intrinsic factors are:

- Available water in the food as expressed by the water activity
- pH value and the total acidity, and the type of acid
- Redox potential
- Available oxygen
- Nutrients
- Natural micro flora and surviving microbial counts
- Natural biochemistry of the product formulation, e.g. the type and amount of enzymes present
- Use of preservatives in product formulations, such as sugar and salt.

Extrinsic factors include a number of extraneous conditions. Major extrinsic factors influencing shelf life of foods include the following:

- Cultural practices in production
- Time-temperature profile during processing
- Temperature and relative humidity control during storage and distribution
- Exposure to light (UV and IR) during processing, storage and distribution
- Environmental microbial counts during processing, storage and distribution

- Composition of atmosphere within packaging
- Mechanical handling in distribution
- Consumer handling
- Subsequent heat treatment (e.g. reheating or cooking before consumption)

The intrinsic and extrinsic factors are often interactive. This is useful in developing strategies to extend shelf life. For example, hurdle effect is a combination of intrinsic and extrinsic factors. , Microbial growth in a food may be restricted by combining the use of antioxidants, reduced storage temperature, use of mild heat treatment during processing, and use of controlled atmosphere packaging.

1.3 Basis of Shelf-Life Studies in Foods

Shelf life studies become integral part of the overall objective of food processing, namely, “safe and wholesome food of consistent quality available at affordable price.” To accomplish this objective, proper and correct evaluation of shelf life of food must be done as part of product development. Therefore it is important that in an early stage of product development, sufficient attention is given to the definition, measurement, and model changes in the food quality. And, the importance of consistency in food quality during distribution and storage is given proper recognition.

1.4 Defining Food Quality

The following two definitions of food quality are helpful in designing shelf life studies:

“the combination of attributes or characteristics of a product that have significance in determining the degree of acceptability of the product to user,” and

“acceptance of the perceived characteristics of a product by consumers who are the regular users of the product category or those who comprise the market segment.”

Both these definitions of food quality emphasize the use of quality characteristics or measurable attributes (either analytically or through sensory studies).

In both these definitions there is reference to food acceptance by the consumer. Food acceptance is based on the sensory and cognitive factors. The following graphical image is useful in determining the acceptance level. This model was initially proposed by Land (1983).

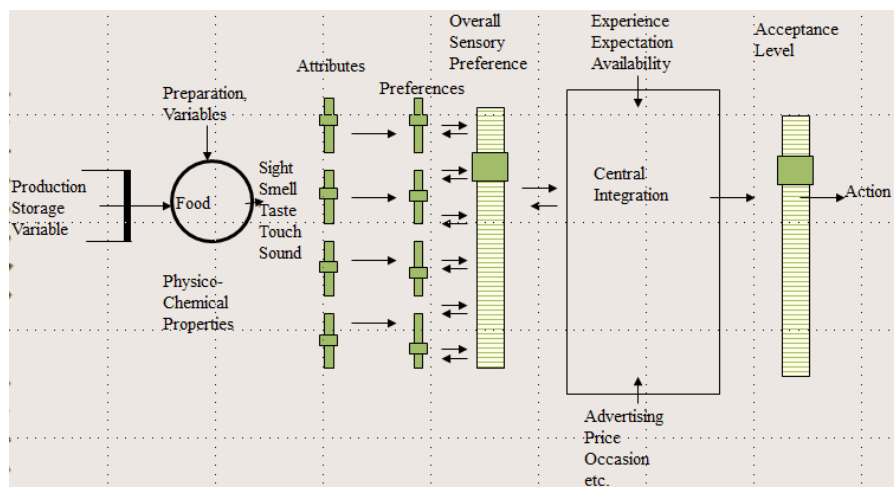


Figure 1: Land's model on food acceptability by consumers. (Taub and Singh (1998))

As seen on the left hand side in Figure 1, various intrinsic and extrinsic variables impact the physico-chemical and stimulant attributes of a food. These attributes interact with the human sensory systems to produce certain sensory experiences such as sight, smell, taste, touch and sound. These attributes in turn lead to sensory preferences. Then there is further interaction with the central nervous system where the previous experience with the product, such as expectations, advertising, familiarity, and price play a role that may modify the sensory preference. The integration of all these factors promotes an action, such as selection, purchase, or consumption.

1.5 Guidelines in Defining Shelf Life of Foods

In defining shelf life we need to keep in mind the following items about foods:

- Foods maintain a dynamic state - - physically, chemically, and biologically. Their quality attributes continue to change, mostly deteriorating. (A few exceptions include aging of wine and cheese where the quality improves with storage).
- For each food, under steady conditions there is a certain time period during which the product retains a desirable level of sensory quality and safety.
- This period of time varies with specific commodity and the intended use of definition (e.g. in marketing or for government regulation)

- This period of time can also be defined as the shelf-life of the food product.

In developing a more objective definition of shelf life, the following expressions developed in a major study on storage of frozen foods in 1960s is helpful.

High Quality Life of Frozen Foods (HQL): The time elapsed between the freezing of an initially high quality product and the moment when, by sensory assessment, a statistically significant difference ($P < 0.01$) from the initial high quality (immediately after freezing) can be established. This is called Just Noticeable Difference (JND). If a triangular test for quality assessment is used, a JND can be postulated when 70% of the experienced tasters successfully distinguish the product from the control sample stored under such conditions as have been proven to produce no detectable degradation during the time under consideration.

The second definition was called **Practical Storage Life (PSL) of Frozen Foods**. The period of frozen storage after freezing, during which the product retains its characteristic properties and remains suitable for consumption or the intended process.

Thus while the HQL is a more strict method to determine the changes in quality attributes, the PSL provides a definition that may be useful in commercial trade.

In summary, for any definition to be used as a working tool, further guidelines are usually needed, i.e. the meaning of sensory quality has to be accurately defined and appropriate methods of measuring it and criteria for setting acceptability limits must be discussed.

1.6 Review Questions:

- a) Discuss three intrinsic and three extrinsic factors that influence the shelf life of meat products.
- b) Discuss two shortcomings of common definitions of shelf life?
- c) What is HQL and PSL?

1.7 References and Additional Reading:

IFT (1974) Shelf life of Foods. *Journal of Food Science*, 39. 1-4

IFST (1993) *Shelf Life of Foods – Guidelines for its Determination and Prediction*. London: Institute of Food Science and Technology.

Land, D.G. (1983) *Sensory Quality in Foods and Beverages*.

Taub, I. and R. P. Singh. (1998) *Food Storage Stability*. CRC Press, Boca Raton, Florida.