



# Advanced Shelf Life Principles

*The Process of Putting Together a Shelf Life Study*

Presented by

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# Shelf-life Study Definition

- A shelf-life study is an objective means to determine how long a product can reasonably be expected to keep, without an appreciable change in quality, safety & character



## Factors Influencing Shelf Life

- Initial quality of the food
- Inherent nature of the product
- Processing methods
- Barrier properties of the packaging
- Transportation and storage conditions (temperature & relative humidity)





# Approach to Shelf Life Studies

1. Define objective
2. Identify mode of deterioration
3. Define key attributes for testing
4. Select test methods to be used
5. Set storage conditions
6. Set approximate end point & testing frequency
7. Determine appropriate test & control samples
8. Perform shelf-life study
9. Analyze results
10. Monitor & confirm shelf life



# 1. Define Objective

- New product
- Change in ingredients
- New package





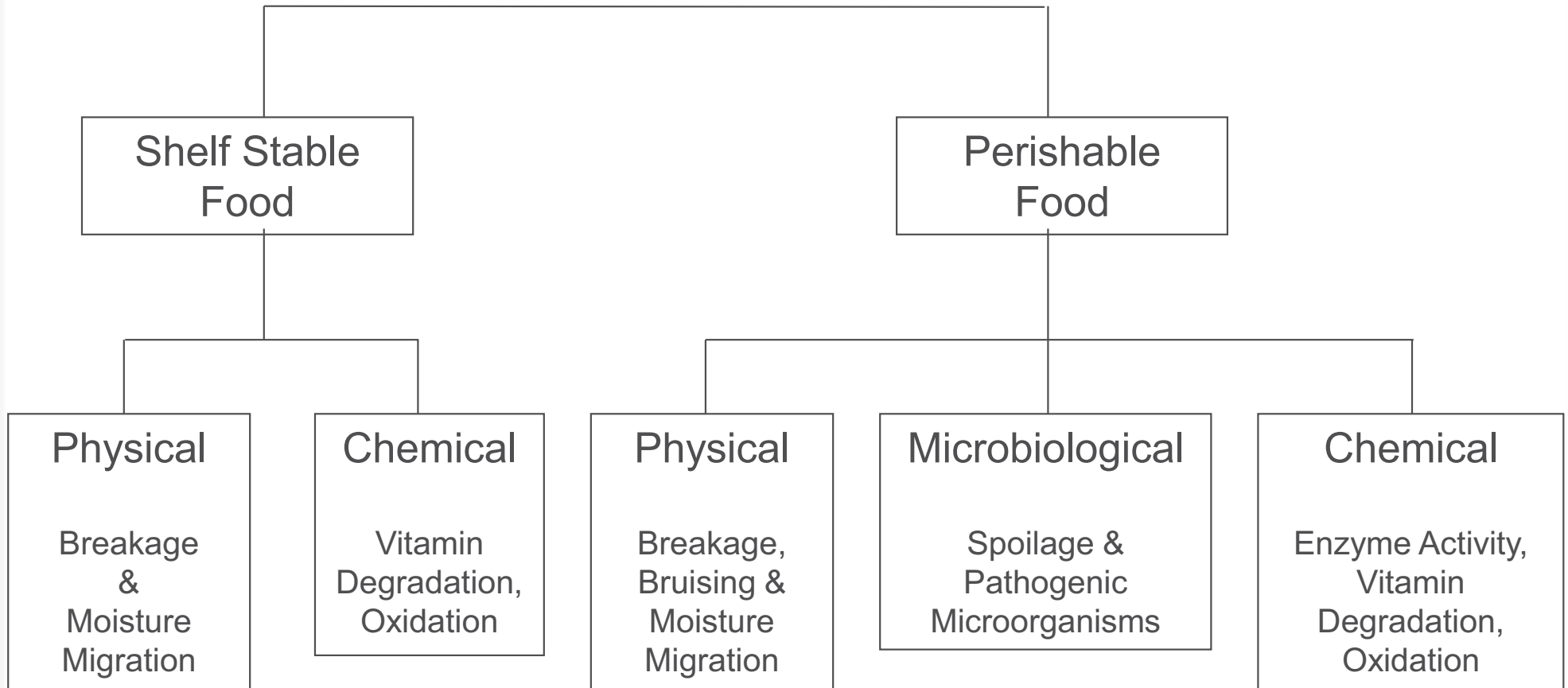
## 2. Identify Mode of Deterioration

- Microbial growth
- Chemical deterioration
  - Oxidation causing change in taste or nutrition
  - Light degradation causing color loss
- Physical deterioration
  - Moisture gain causing clumping
  - Moisture loss causing drying



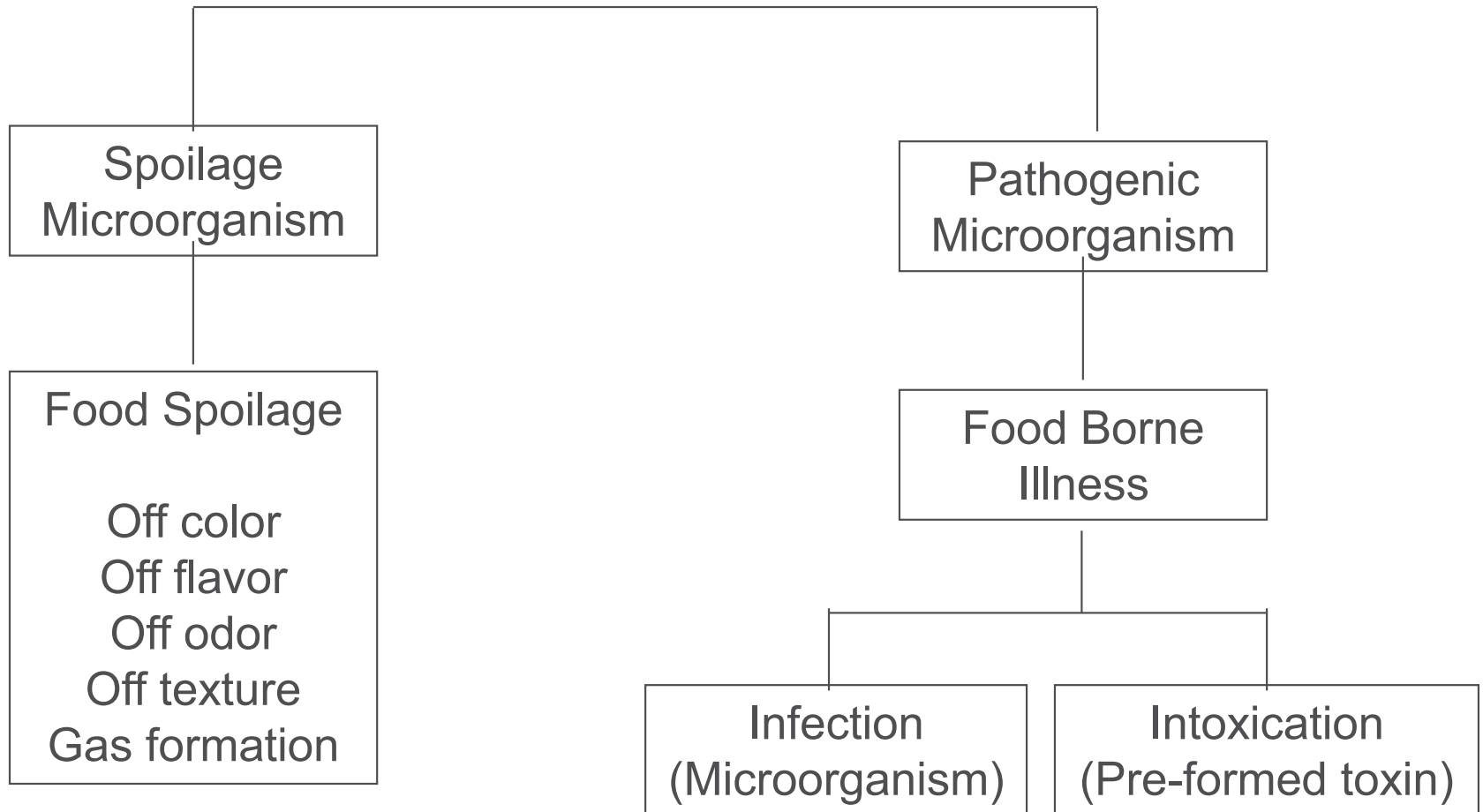


# Food Deterioration





# Microbiological Activity





## Microbial Activity

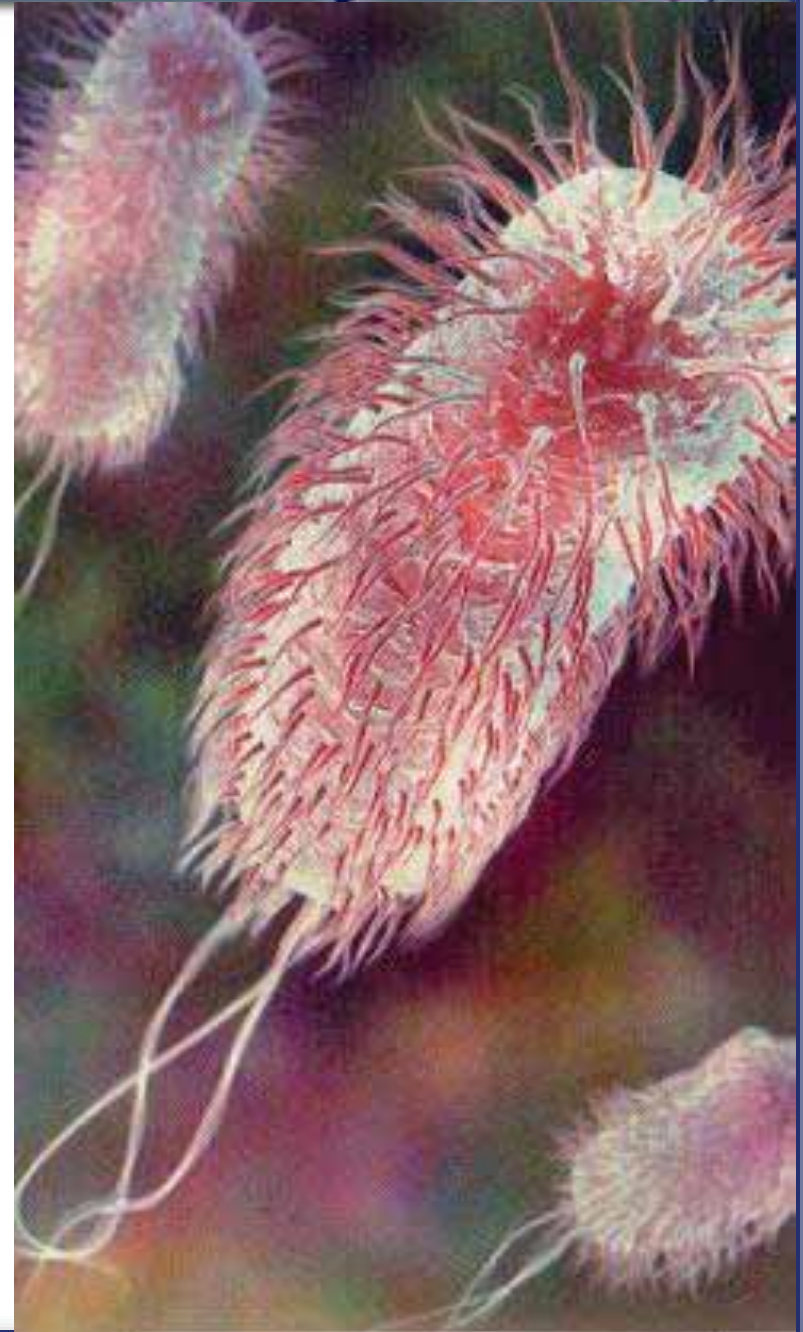
- Growth depends on environmental conditions
- Different microorganisms grow in different environments and at different rates





# Factors Influencing Microbial Growth

- Nutrients & chemical properties of food
- Water
- Temperature
- Acidity
- Oxygen
- Chemicals





# Preventing Microbial Spoilage

1. Create conditions unfavorable for microbial growth
  - Reduce temperature
  - Reduce water activity
  - Lowering pH
  - Modify atmospheric condition
  - Add preservatives (sodium benzoate, sorbic acid, propionic acid, sulfur dioxide, sulfites, nitrites and nitrates)
2. Kill microorganisms
  - Heat treatment (Retort & UHT Aseptic)
  - Gentle processing techniques i.e. HPP



### 3. Define Key Attributes for Testing

- Microbial examination
- Analytical testing
  - Chemical analysis (i.e. vitamin degradation, lipid oxidation by-products)
  - Physical testing (i.e. color or textural change)
- Sensory evaluation
  - Appearance, taste, texture, odor

Note: Key part of establishing usefulness of any analytical measurement is correlation with sensory quality



## 4. Select Test Methods to be Used

### Sensory Evaluation

- Descriptive
- Discrimination
- Affective Testing



Consider physical facility, sample preparation, panelist, experimental design, statistical tests



## 4. Select Test Methods to be Used

### Sensory Evaluation

- Descriptive: Profile or Category Scales
  - When changes in product profile or appearance are expected
  - Allows a number of attributes to be monitored
  - Trained panelists required



## 4. Select Test Methods to be Used

### Sensory Evaluation

- Discrimination: Looking for Differences
  - When changes in product are not expected to be visual
  - Product is compared to a control sample (Triangle, Duo-Trio, 2 out of 5, Degree of Difference)
  - Used for products that do not change considerably and are less complex in profile
  - Trained panelists not required



## 4. Select Test Methods to be Used

### Sensory Evaluation

- Affective Testing: Consumer Acceptability
  - When consumer acceptability or preference is the key driver
  - Expensive to conduct across shelf life since large number of consumers (>100) required



## 5. Set Storage Conditions

- Temperature
- Relative humidity
- Lighting
  
- Optimal, typical or average, worse case condition
  
- Fixed or fluctuating





## 6. Set End Point and Testing Frequency

- Short shelf life (7 to 10 days): daily or every two day
- Medium shelf life (3 weeks) and long shelf life (1 year): Initial point, end point, 2 to 3 occasions in between, and one point beyond end point

Example frequency:

0, 25, 50, 75, 100 and 125% of target shelf life

0, 50, 100 and 125% of target shelf life (minimum)

- Additional times can be added based on product knowledge (early or late product changes)



## 7. Determine Test and Control Samples

- Set ingredients, process and packaging
- Samples from same batch
- Sensory control (freshly manufactured or stored with minimal deterioration)
- Duplicate or triplicate testing for micro and analytical tests





## 8. Perform Shelf Life Study

- Store samples under conditions outlined in study
- Take samples at determined test intervals
- Subject samples to appropriate tests



## 9. Analyze Results

- What is the maximum **safe** shelf life?
- What is the maximum **quality** shelf life?
- Do the maximum safe and quality shelf lives meet the target shelf life?

Last day of acceptable score or results  
considered shelf-life date

## 10. Monitor and Confirm Shelf Life

- Sample at distribution and retail level, adjust shelf life
- Set final shelf life based on worst case manufacturing and storage scenario for safety margin





# Accelerated Shelf-life Testing

- Used to gather information quickly
- Most common form uses elevated temperature storage
- Based on Arrhenius model where rate of reaction increases with temperature
- Most studies done on chemical deterioration of foods
- Can only be used if a relationship exists between the storage behavior under normal conditions and under accelerated conditions
- Appropriate for simple chemical systems but in reality foods are more complex



# Accelerated Shelf Life Determination(ASLD)

## Limitations:

- Increasing temperature may lead to change in physical state (i.e. melting of solid fats)
- Relative humidity may affect reaction rate
- Reactions that would not occur at normal temperatures can happen
- Not applicable for short shelf life chilled foods where spoilage microorganism flourish at different temperatures
- Can only be used if a relationship exists between the storage behavior under normal conditions and under accelerated conditions



# Summary

- It is important to understand the mode of food deterioration in order to establish the product's shelf life
- Product formulation, process conditions and storage conditions are important considerations for product shelf life
- Careful consideration of experimental design and test parameters is essential for accurate shelf-life evaluation
- The shelf life of commercial products should be monitored and adjusted accordingly



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# Mocon's Advanced Packaging Solutions

Modes of Food Deterioration

Shelf-life Modeling and Studies

Microbial Studies

Accelerated Aging Studies

Chemical and Physical Analysis of food and

packaging

Gas Mix Optimization

MAP Systems Audits

Shelf-life Optimization

Transportation Testing

Human evaluation panels





# Questions?

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