Shelf Life Determination - Food

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Shelf life Definition

“The amount of time that a food product is considered acceptable for consumption when stored at the appropriate storage conditions” – NACMCF

Mostly shelf life is concerned with product quality however most consumers would perceive that food-safety is also maintained during a food’s nominated shelf life

Food safety is typically NOT accessed as part of a shelf life investigation. Should be addressed via –

- Pre-requisite programs
- HACCP
- Challenge Studies
Shelf life is NOT just about microbiology and always and without exceptions includes the following –

- Microbiology
- Chemistry – Tests for Rancidity, moisture pick up, loss of specific ingredients.
- Sensory / Organoleptic – Taste, odour, colour changes, textures.

It is the combination of all these tests and the lowest time link that determines shelf life.
The legal requirement for manufacturers of packaged foods to date mark foods was first introduced into Australia in 1978.

The current Food Standards Code
- Standard 1.2.5 “Information requirements – date marking of food for sale”
- Use-by-date or Best-Before-Date

Guide to Standard 1.2.5
- Page 9: Decision tree

Responsibility
- It is the responsibility of the food manufacturer/packer to determine the shelf life of a food and thus its UBD or Best before Date.
Global Food Losses

- Estimated that 25% of world’s food supply is lost to microbial spoilage

- United States:
  - 28% of total food supply lost (44/166 billion kilos)
    - 2% Retail
    - 26% Consumer and Foodservice
No single factor may determine the shelf life of a food but the most important to be considered in shelf life studies are:

- Microbiological changes
- Chemical / Biochemical Changes
- Sensory
The rate of microbial population growth is determined by a number of factors including:

- **Intrinsic properties**
  - pH
  - total acidity
  - water activity
  - presence of preservatives

- **Environmental Factors**
  - Temperature
  - Relative humidity
  - Gaseous atmosphere

- **Any process designed to kill and retard growth of microorganisms**
  - Thermal process
  - Freezing
  - Packaging e.g. MAP
Many reactions can limit the shelf life of food. The most important are:

- Oxidation – rancidity e.g. nuts
- Non-enzymatic browning e.g. maillard reactions
- Enzymatic browning e.g. fruits
- Food packaging interaction
- Moisture loss / pick up e.g. cakes, biscuits

While freezing arrests microbial activity, chemical reactions proceed at a much reduced rate even at recommended storage temperatures.

Examples of frozen foods whose storage life is limited by oxidation include fish and meats.
MXNS undertakes basic Sensory Assessment

- Appearance, for example
  - Enzymatic browning e.g. vegetables, fruits
  - Non-enzymatic browning reactions e.g. Maillard reactions
  - Greening of meat surfaces
  - Blooms on chocolate
  - Color change due to pH change

- Odour - basic comparative assessment only
- Texture – basic comparative assessment only
- State of packaging

Taste testing – should be undertaken by the client
Parameters to consider

- Study Duration
- Tests – Microbial (TVAC, Y&M), Chemical, Sensory
- Testing Frequency
- Number of Lots / batches
- Replicates per lot / batch
- Storage temperature – optimal, abuse

Accelerated studies (incubation at elevated temperatures) may be applicable for some chemical parameters e.g. rancidity

Computer based models may also be useful e.g. predictive tool
Real time vs Accelerated

- Accelerated shelf life studies
  - Store products at elevated temperature / humidity / light intensity etc.
  - Elevated storage conditions translate to savings in storage time
  - Calculations to convert accelerated results to real time shelf life are complex,
  - Not suitable for assessing Microbiological shelf life
  - Typically used for pilot batches of product
  - Production batches should be verified using real time studies

- Example of shelf life prediction

<table>
<thead>
<tr>
<th>Temperature above labelled storage conditions</th>
<th>Time period</th>
<th>Test time points</th>
<th>Possible shelf life prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>+10°C</td>
<td>6 months</td>
<td>0, (1 or 2), (3 or 4), 6 months</td>
<td>2 years</td>
</tr>
<tr>
<td>+10°C</td>
<td>9 months</td>
<td>0, (1 or 2), (3 or 4), (5 or 6), 9 months</td>
<td>3 years</td>
</tr>
<tr>
<td>+15°C</td>
<td>6 months</td>
<td>0, (1 or 2), (3 or 4), 6 months</td>
<td>3 years</td>
</tr>
</tbody>
</table>
Candidates for accelerated shelf life studies (Non micro assessment)
- Shelf stable
- Frozen products with a shelf life of six months or more

Samples unsuitable for accelerated shelf life studies
- Refrigerated products
- Product that spoil due to microbial growth
Common Errors in Shelf life Design

- Microbiology performed when none needed, e.g. low a\textsubscript{w} foods (<0.60), frozen foods – if food remains frozen no microbial growth occurs

- Too few test points so point of microbiological or chemical instability is not accurately determined – driver is cost reduction

- Single batch studies often requested – driver is cost reduction

- Too few replicates per batch – driver is cost reduction

- Pathogen tests requested without sound rationale

- Often based on optimum conditions and minimal research
Gather Product Information

1. MXNS Shelf life Evaluation Form (Form 450)
   - Client provide info – pH, Aw, Cook temp, preservatives storage temperature, packaging, modified gaseous conditions etc.

Design Shelf Life Protocol

2. Product information analysed
   - Tailored protocol written and sent to client for approval (in the absence of a client specific protocol)

Testing & Reporting

3. Samples received, registered, stored & tested as per approved protocol
   - Regular updates provided to client. Option to halt testing if limits exceeded
   - Results collated, analysed and reported. Shelf life recommended back to client
Typical shelf life analysis

TVAC
(Total Viable Aerobic Count)

Yeast & mould

Sensory

Indicators – *E. coli*, Enterobacteriaceae

Psychotropic organisms counts

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### FSANZ – Compendium of Microbiological Criteria for Food (October 2016)

- **4 Categories of Food**

#### Table 3. Interpretation of results for *mesophilic aerobic bacteria* (MAB) colony count (at 30°C) in RTE foods

<table>
<thead>
<tr>
<th>Food Category</th>
<th>Examples</th>
<th>Result (cfu/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 1</td>
<td>Applies to foods cooked immediately before consumption</td>
<td>Satisfactory: (&lt; 10^6)</td>
</tr>
<tr>
<td>Category 2</td>
<td>Applies to RTE foods in which all components of the foods have been cooked but there is some handling before sale or consumption.</td>
<td>Satisfactory: (&lt; 10^6)</td>
</tr>
<tr>
<td>Category 3</td>
<td>Applies to RTE foods which contain some components that have been cooked and then further handled (stored, sliced or mixed) before preparation of the final food or where no cooking process has been used.</td>
<td>Satisfactory: (&lt; 10^6)</td>
</tr>
<tr>
<td>Category 4</td>
<td>Foods in level 3 either have an inherently high plate count because of the normal microbial flora present or as a result of the processing received. Includes fermented, preserved and dried food products and fresh fruit and vegetables.</td>
<td>Satisfactory: N/A</td>
</tr>
</tbody>
</table>
### Table 2. Interpreting results for testing of *indicator organisms* in ready-to-eat foods

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Result (cfu/g)</th>
<th>Interpretation</th>
<th>Likely cause</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Enterobacteriaceae</em> (includes coliforms)</td>
<td>$&gt;10^4$</td>
<td>Unsatisfactory</td>
<td>For processed foods indicates that contamination has occurred post processing (cross contamination from food contact surfaces, raw products or food handlers) or there has been inadequate processing. Poor temperature time control may also be a contributing factor.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$10^2 - 10^4$</td>
<td>Marginal</td>
<td>Some cross contamination or inadequate processing indicated.</td>
<td>Proactive investigation to ensure processing and hygiene controls are being implemented. Results may need to be compared with other food samples from the production environment for interpretation.</td>
</tr>
<tr>
<td></td>
<td>$&lt;10^3$</td>
<td>Satisfactory</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| *Escherichia coli*  | $>10^3$      | Unsatisfactory | For raw and processed foods indicates potential for there to have been contamination of faecal origin from poor hygienic practices (cross contamination from food contact surfaces, raw foods or food handlers) or there has been inadequate processing. For RTE foods that have not been processed (e.g. fresh produce), contamination from the primary production environment should be considered. | • Review:  
  — processing controls used (such as cooking temperatures)  
  — cleaning and sanitising practices for premises and equipment  
  — food handler hygiene  
  — time and temperature control  
  — primary production controls (e.g. harvest practices, water quality, fertilizers, other inputs as appropriate).  
  Additional food or environmental samples may be required for investigation and testing for enteric |
The Scientific Services Department of MXNS Australia is based in our Head Office (HO) in Melbourne. Generation of protocols & reporting are centralized in the HO.

For Adelaide & Tasmania, samples are sent to the Melbourne lab.
In Summary

- Not set formula - each product must be assessed
- All information must be available to make informed decision on product safety, appropriate test parameters and incubation condition
- In some cases Challenge studies may be preferred option
- May require a multi disciplinary approach not just microbiological tests
- Timeline of study will reflect real time life of the product
- Secondary shelf life can be considered
- Contact MXNS for your shelf life testing requirements
  - sales.au@mxns.com
  - david.lim@mxns.com
References

- Shelf life Evaluation of Foods 1997 ed C.M.D.Man and A.A.Jones Blackie Academic and Professional

- Shelf Life Food Industry Briefing Notes Blackwell Science Oxford U.K.2002 Man D.

- Understanding and Measuring the shelf Life of Foods 2004 Steele R.ed Woodhead Publishing Ltd Cambridge UK

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- Food Science Australia
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