SHELF LIFE OF FOODS

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Food Packaging and Shelf Life

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OVERVIEW

- DEFINITION
- SHELF LIFE LABELLING
- FACTOR CONTROLLING SHELF LIFE
- CLASSIFICATION OF SHELF LIFE TESTING
- CONCLUSION

I. DEFINITION

- ***The National Food Processors Association*** **in USA (1978):**

  A product is within its shelf life when it is neither misbranded nor adulterated, when the product quality is generally accepted for its purposted use by a consumer, so long as the container retains its integrity with respect to leakage and protection of the content.

I. DEFINITION

- ***The Institute of Food Technologist in USA*** **:**

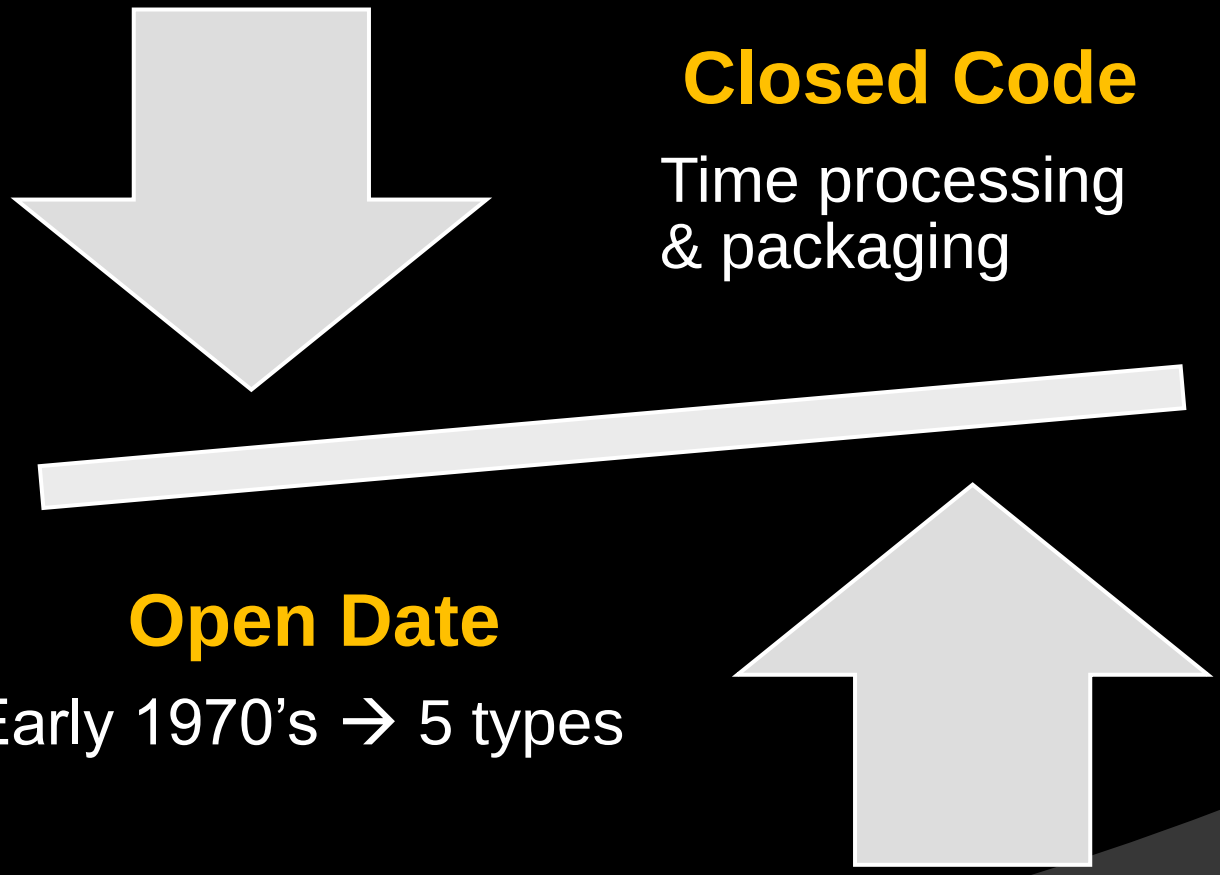
  The period between the manufacture and the retail purchase of a food product, during which time the product is in a state of satisfactory quality in term of nutritional value, taste, texture, and appearance.

I. DEFINITION

- *Hine DJ (1987)*:

  The duration of that period between the packing of a product and its use, for which the quality of the product remains acceptable to the product user.

II. SHELF LIFE LABELLING



Closed Code

Time processing
& packaging

Open Date

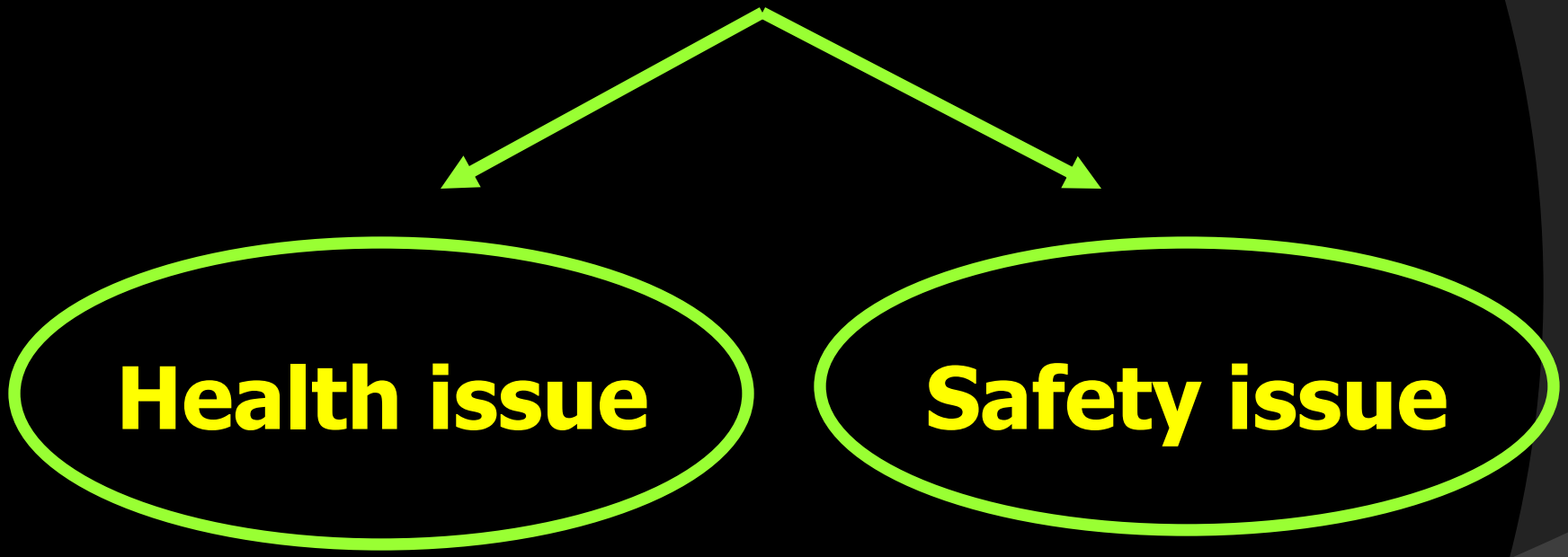
Early 1970's → 5 types

SHELF LIFE LABELLING (Open Date System)

- **Pack Date :** the date on which the product was packed into its primary package.
- **Display Date :** the date on which the product was placed on the shelf by the retailer.
- **Pull Date/Sell by Date :** the last date on which the product should be sold in order to allow the consumer a reasonable length of time in which to use it.
- **Best Before :** the last date of maximum high quality.
- **Use by date/Expired date :** the date after which the food is no longer at an acceptable level of quality.

II. SHELF LIFE LABELLING

Best before vs Use by date



II. SHELF LIFE LABELLING

Health issue

Use by :

Foods which is consumed by people with a particular illness to get its nutrition.

II. SHELF LIFE LABELLING

Safety issue

Foods that are microbiologically unsafe before the physical or visual deterioration.

Use by date cannot be used for :

- ***shelf stable food***
- ***frozen food***
- **raw food**

Chilled ready-to-eat food is labelled with *use by date if* :

- contain toxin producing bacteria which grow during refrigeration temperature.
- promote the growth of toxin producing bacteria at the dangerous level before physical deterioration.
- did not cook or process well before consumption.

Toxin Producing Bacteria which grow during refrigeration temperature :

- ***Listeria monocytogenes***
- **strain of *Bacillus cereus***
- **strain of *Clostridium botulinum***
- ***Yersinia enterolitica***

III. FACTOR CONTROLLING SHELF LIFE

- Product Characteristics
- Distribution Environment
- Package Properties

A. Product Characteristics

- Perishability
- Bulk Density
- Concentration Effects

Perishability

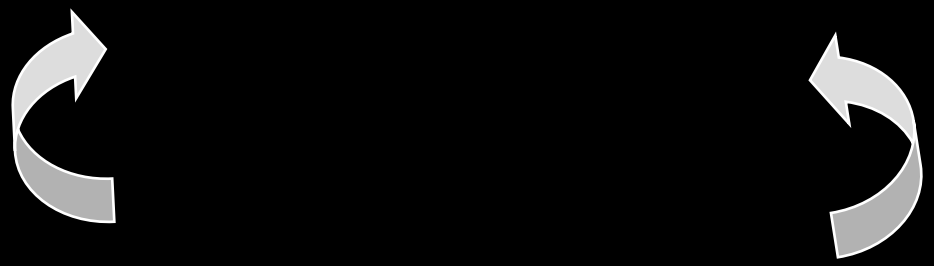
- *Perishable* :
  - ❖ Must be held at chill temperature (0-7°C)
  - ❖ Must be held at freezer temperature (-12 to -18°C).
- *Example* :
  - ❖ Fresh milk, fruit & vegetables should be kept at chill temperature
  - ❖ Poultry, fish, and meat should be kept at freezer temperature

Perishability:

- *Semi perishable*
  - Foods which contain natural inhibitors (cheese, root vegetables, eggs)
  - Foods which have received some type of mild preservation (pickle, pasteurized milk)
- *Non perishable / shelf stable*
  - Foods which contain low moisture content (cereal grains, nuts, some confectionery)
  - Foods which have preserved by heat sterilization (UHT milk, canned food)
  - Foods which contain preservatives (soft drinks)
  - Formulated dry foods (crackers)

- **Bulk Density**

Free space volume of package (Vf)



bulk density (ρ_b) **true density (ρ_t)**

Vf = VT-Vp

Bulk Density

$$Vf = VT - Vp = \frac{W}{\rho_b} - \frac{W}{\rho_t}$$

VT = Volume Total
Vp = Volume Product
Vf = Free space volume of package
W = Weight of the product

- The **free space volume** has an important influence on the **rate of oxidation** of foods.
- Large free space volume is **undesirable** since it constitutes a large oxygen reservoir.

Concentration Effects

- There are initial inhomogeneities and discontinuities for each compound.
- "Brush-fire effect" → important in chain reaction such as oxidation.
- Deteriorative reaction can be monitored by following the change in concentration of some key component
- Different stages of the deteriorative reaction may have different dependence on concentration & temperature, giving disguised kinetics. Ex : microbial growth

B. Distribution Environment

- Climatic
  1. Mass Transfer
  2. Heat Transfer
- Physical

- **Climatic**

  Mass Transfer :

  Difference partial pressure between water vapour and gasses.

  Heat Transfer :

  The reaction kinetics is influenced by temperature.

- **Physical**

  Effect of transportation, handling during storage, stacking.

C. Package Properties

- Moisture Vapor Transfer
- Gas and Odor Transfer
- Package/Product Interaction

SIFAT PENGEMAS:

Tiap bahan / produk pangan memerlukan proteksi yang berbeda

Tiap pengemas mempunyai sifat perlindungan (permeabilitas) dan reaktitivitas yang berbeda

Permeability Coefficient Unit (P)

$$P = (Q \times h) / (a \times t \times p)$$

Q = Quantity of permeant under stated condition (10^{-11} mL at STP)

h = thickness (cm)

a = area (cm^2)

t = time (s)

p = pressure drop across polymer (cm Hg)

Permeance (P/X)

Permeability constant (P) divided by the thickness of the film (X)

Rate of gas or vapor transport across the film/thermoplastic material (dw/dt)

- **dw/dt = P/X . A . (p1-p2)**

- P = permeability constant
- X = thickness of the film
- A = surface area of the package
- p1 & p2 = partial pressure of water vapour outside and inside the package

- **Transfer uap air dan gas**

  Permeabilitas tiap bahan pengemas thd transfer uap air dan gas berbeda

- **Interaksi pengemas / produk**

  Ex:

  Produk olahan tomat dikemas dengan *three piece can* dan body *tin plate* dilapisi ECCS:

  ion timah dan besi

  ⤷

  skor flavor dan warna

IV. SHELF LIFE TESTING

- Experiments designed to determine the shelf life of **existing products**.
- Experiments designed to study the **effect** of **specific factors** and its combination (ex : storage temperature, packaging materials).
- To determine the shelf life of **prototype** or **newly developed** products

Determining Shelf Life of a Food Product

- **Literature Study**

  The shelf life of an analogous product is obtained from the published literature or in-house company files.

- **Turn over time**

  The average length of time which a product spends on the retail shelf is found by monitoring sales from retail outlets, and from this the required shelf life is estimated.

Determining Shelf Life of a Food Product

- **End Point Study**

  Random samples of the product are purchased from retail outlets, and then tested in the laboratory to determine their quality (estimated of shelf life during warehousing and retailing).

- **Accelerated Shelf Life Testing (ASLT)**

  Environmental conditions are accelerated by a known factor so that the product deteriorates at a faster than normal rate.

PENGUJIAN UMUR SIMPAN

Berdasar faktor yang mempengaruhi reaksi kerusakan:

- Reaksi yang dipengaruhi oleh transfer panas
  ex: reaksi oksidasi lemak,
  reaksi Maillard

- Reaksi yang dipengaruhi oleh transfer massa
  ex: perubahan kadar air produk

PENGUJIAN UMUR SIMPAN

Berdasar jenis data yang digunakan:

- **Data dari pengujian fisik, kimia, mikrobiologis**
- **Data dari pengujian sensorik**

Langkah-langkah Penentuan Umur Simpan

- Tentukan **parameter mutu** secara fisik/kimia/mikrobiologi yang merupakan **kunci reaksi kerusakan** dan menyebabkan penurunan kualitas produk dan penolakan oleh konsumer,
- Tentukan jenis uji yang akan digunakan pada percobaan penentuan umur simpan

Langkah-langkah Penentuan Umur Simpan

- Pemilihan **pengemas** yang digunakan untuk pengujian umur simpan.
- **Memilih faktor ekstrinsik** yang digunakan untuk mempercepat reaksi kerusakan, misal suhu

Jenis produk	Suhu pengujian (°C)	Suhu kontrol (°C)
Makanan dalam kaleng	25, 30, 35, 40	4
Pangan kering	25, 30, 35, 40, 45	-18
Pangan dingin	5, 10, 15, 20	0
Pangan beku	-5, -10, -15	<-40

Langkah-langkah Penentuan Umur Simpan

- Menentukan **frekuensi tes**. Suhu yang tertinggi tidak akan lebih lama dibanding dengan suhu yang lebih rendah.
- Menghitung **jumlah sample** yang akan disimpan pada masing-masing tes, termasuk kontrol.
- Menggunakan prediksi reaksi atau **plot umur simpan** untuk menentukan berapa lama umur simpan produk.

TRANSFER PANAS
(Heat Transfer)

- ***Prediksi Reaksi***
- ***Plot Umur Simpan***

Prediksi Reaksi

* ***Data yang tersedia:***
  faktor mutu pada satu suhu

* ***Fungsi:***
  menentukan konstanta kecepatan reaksi (k) atau umur simpan (θs) pada satu suhu

Prediksi Reaksi:

- **Reaksi Orde Nol**

$$A_o - A_e = k.\theta_i$$

- **Reaksi Orde Pertama**

$$\ln A - \ln A_o = k.\theta_i$$

A = faktor mutu
k = konstanta kecepatan reaksi
θ_i = waktu

Plot Umur Simpan

*** *Data yang tersedia:***

konstanta kecepatan reaksi (k) atau umur simpan (θ_s) pada beberapa suhu

*** *Fungsi:***

menentukan konstanta kecepatan reaksi (k) atau umur simpan (θ_s) pada beberapa suhu yang lain

Plot Umur Simpan:

- **Model Arrhenius**
- **Model Linear**
- **Model Q_{10}**

Plot Umur Simpan:

- **Model Arrhenius**

$$\ln k_o - \ln k = E_A/R.T$$

- **Model Linear**

$$\ln k_o - \ln k = b.(T - T_o)$$

Lanjutan

Plot Umur Simpan:

- **Model Q_{10}**

$$Q_{10} = \frac{k_{T+10}}{k_T}$$

k = konstanta kecepatan reaksi
T = suhu
E_A = energi aktivasi
b = karakteristik konstan dari reaksi

TRANSFER MASSA
(Mass Transfer)

- ***Transfer Uap Air***
- ***Transfer Gas dan Bau***

Transfer Uap Air

$$\ln \frac{m_e - m_i}{m_e - m_c} = \frac{P}{X} \cdot \frac{A}{W_s} \cdot \frac{p_o}{b} \cdot \theta_s$$

Lanjutan

m_e = kadar air setimbang
mi = kadar air awal
m = kadar air bahan pd waktu tertentu
P = konstanta permeabilitas
X = ketebalan film
A = luas permukaan pengemas
W_s = berat bahan
p_o = tekanan uap air murni
b = slope

$$\ln \frac{m_e - m_i}{m_e - m_c} = \frac{P}{X} \cdot \frac{A}{W_s} \cdot \frac{p_o}{b} \cdot \theta_s$$

$$\frac{P}{X} \cdot \frac{A}{W_s} = \Omega$$

θ_s maximum → Ω minimum

jenis dan ketebalan film

$$\ln \frac{m_e - m_i}{m_e - m_c} = \frac{P}{X} \cdot \frac{A}{W_s} \cdot \frac{p_o}{b} \cdot \theta_s$$

$$\theta_s = \Phi \cdot \frac{W_s}{A} = \Phi' \cdot \frac{V}{A} = \Phi'' \cdot r$$

Ukuran kemasan kecil ➡ $\frac{V}{A}$ kecil

dasar pengujian : θ_s pendek
(tidak *overestimate*)

Transfer Gas dan Bau

$$\theta_s = \frac{Q \cdot X}{P \cdot A \cdot \Delta p}$$

P/X = permean
A = luas permukaan pengemas
Δp = beda tekanan parsial gas di dlm & di luar kemasan
Q = jumlah gas maksimum yang diijinkan

Te Ri Ma Ka Sih