MANAGING SHELF LIFE OF FOODS

ITP 506

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Southeast Asian Food & Agricultural Science & Technology (SEAFAST) Center

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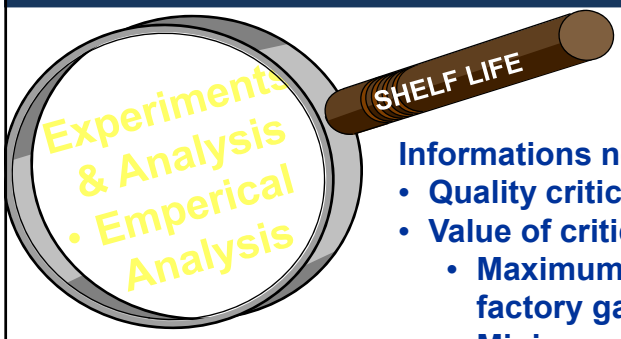
1 CASE OF SHELF LIFE DETERMINATION



Informations needed :

- **Quality critical factor(s)?**
- **Value of critical factor(s)**
  - **Maximum value (quality at the factory gate)**
  - **Minimum value of critical factor(s) : minimum quality at the end of shelf-life**
- **Kinetic parameters for quality changes (E_a, Q_{10})**

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1 CASE OF SHELF LIFE DETERMINATION

KINETIC OF QUALITY CHANGE

A → B

$-dA/dt = kA^n$

Measure either loss of A, desirable quality marker, or production of B, undesirable quality marker

A = quality
t = time
k = rate constant
n = reaction order

1 CASE OF SHELF LIFE DETERMINATION

KINETIC OF QUALITY CHANGE

Zero order (n=0) quality changes

→ $-dA/dt = kA^n$

$$-\frac{dA}{dt} = k[A]^0 = k_z$$

$$\int_{A_0}^{A} -dA = \int_{0}^{t} k_z dt$$

$$-[A - A_0] = k_z t$$

$$A = A_o - k_z t$$

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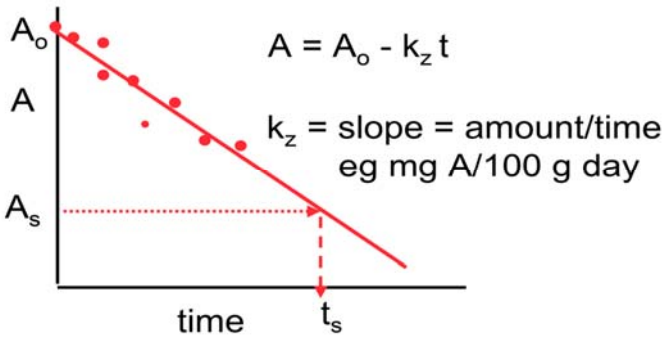
CASE OF

SHELF LIFE DETERMINATION

KINETIC OF QUALITY CHANGE

Zero order (n=0) quality changes

→ $-dA/dt = k_z$ → or, $A = A_o - K_z t$



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CASE OF

SHELF LIFE DETERMINATION

KINETIC OF QUALITY CHANGE

Zero order (n=0) quality changes

→ $-dA/dt = k_z$ → or, $A = A_o - K_z t$

If Q_s is quality level at the end of shelf life, then

$A_s = A_0 - k_z t_s$

or

$t_s = (A_0 - A_s)/ k_z$

at which

t_s is shelf life of the product

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CASE OF

SHELF LIFE DETERMINATION

KINETIC OF QUALITY CHANGE

Zero order (n=0) quality changes

→ $-dA/dt = k_z$ → or, $A = A_o - K_z t$

Just Illustration:

A_o = 100 units at time zero
A = 60 units at 20 weeks
What is k_z if quality change follow zero order ?

Remember, k_z is a slope→ $\Delta Y/\Delta X$
= (100-60)/(20-0)= 40/20 = 2 units per week
Thus 2 units per week x 20 weeks is loss of 40 units
(with 60 units of quality left)

1

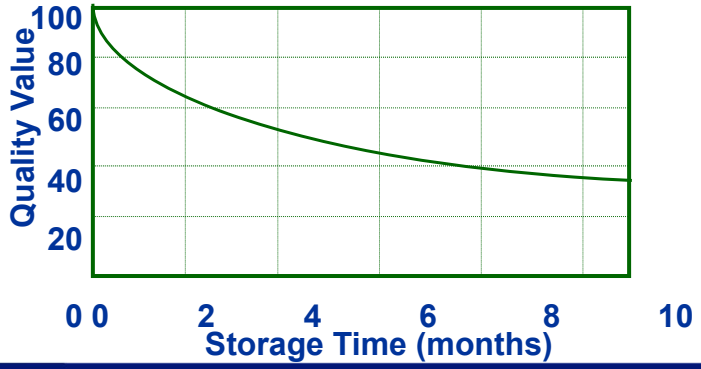
CASE OF

SHELF LIFE DETERMINATION

KINETIC OF QUALITY CHANGE

First order (n=1) quality changes

→ $-dA/dt = k_f A^1$ → or, $-dA/dt = k_f A$



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CASE OF

SHELF LIFE DETERMINATION

KINETIC OF QUALITY CHANGE

First order (n=1) quality changes

→ $-dA/dt = k_f A^1$ → or, $-dA/dt = k_f A$

$$-\frac{dA}{dt} = k_f A$$

$$\int_{A_0}^{A} -\frac{dA}{A} = \int_{0}^{t} k_f dt$$

$$-\ln\left[\frac{A}{A_0}\right] = k_f t$$

$$\ln\left[\frac{A}{A_0}\right] = -k_f t$$

$$A = A_0 e^{-k_f t}$$ → *or;* $\ln (A/A_0) = - kt$

1

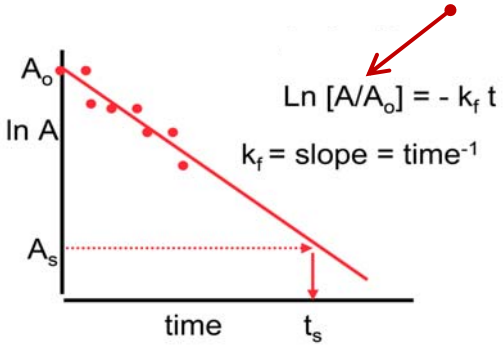
CASE OF

SHELF LIFE DETERMINATION

KINETIC OF QUALITY CHANGE

First order (n=1) quality changes

→ -dA/dt = $k_f A^1$ → or, -dA/dt = $k_f A$



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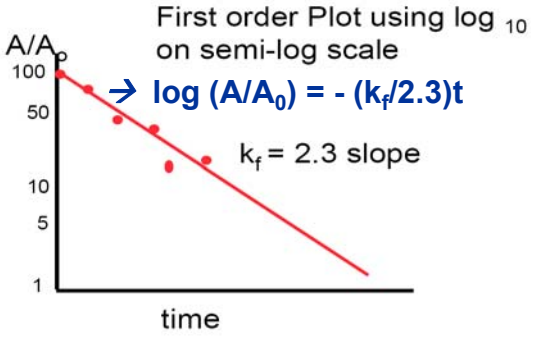

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CASE OF

SHELF LIFE DETERMINATION

KINETIC OF QUALITY CHANGE

First order (n=1) quality changes

→ $-dA/dt = k_f A^1$ → or, $-\ln(A/A_o) = k_f t$

If A_s is A at the end of shelf life, then

$$\ln (A_s/A_0) = - k_f t_s$$

Or

$$t_s = [\ln(A_0/A_s)]/k_f$$

Or

$$t_{1/2} = 0{,}693/ k_f$$

At which t_s is shelf life of product

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CASE OF

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KINETIC OF QUALITY CHANGE

First order (n=1) quality changes

→ $-dA/dt = k_f A^1$ → or, $-\ln(A/A_o) = k_f t$

Just Illustration :

Ao = 100 units at time zero
A = 60 units at 20 weeks
What is k_f if quality changes follows first order?
Remember slope is ΔY/ΔX but on Ln scale so
= (Ln(60/100))/(20-0) = 0.51/20
= 0.02554 week-1

$A= A_o e^{-k_f t}$ → $A= 100 \times e^{-0.02554 \times 20} = 100 \times e^{-0.511} = 60$

1

CASE OF

SHELF LIFE DETERMINATION

Examples of kinetic of quality change of selected product during storage/processing

Zero Order

- **Overall quality of frozen food**
- **Non-enzimatic browning**

First Order

- **Vitamin loss/degradation**
- **Mikcorbial inactivation**
- **Oxidatif deterioration of color**
- **Thermal degradation of texture**

Check on Literatures

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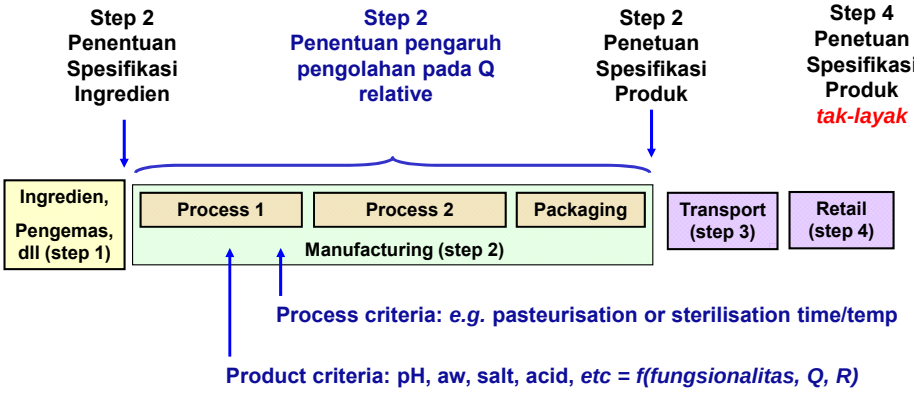
2. Shelf Life → Ingredient?



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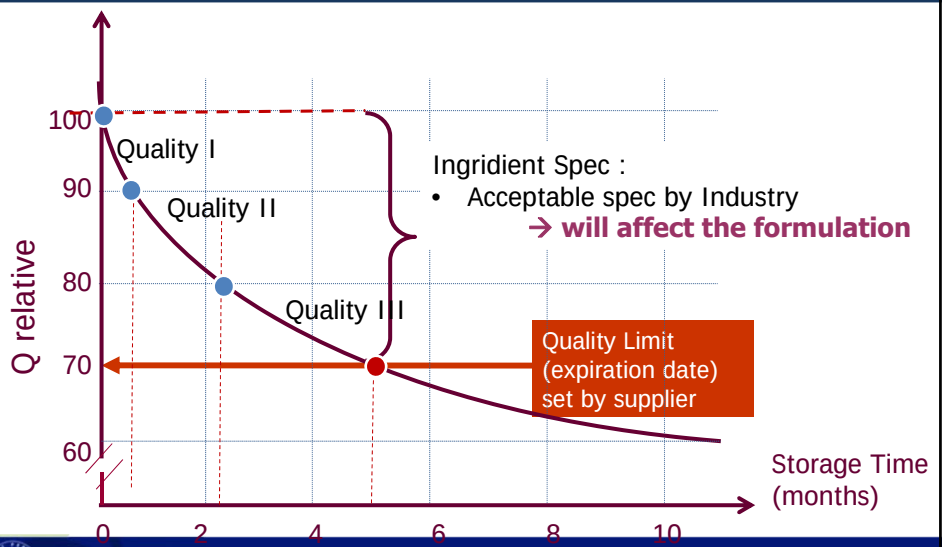

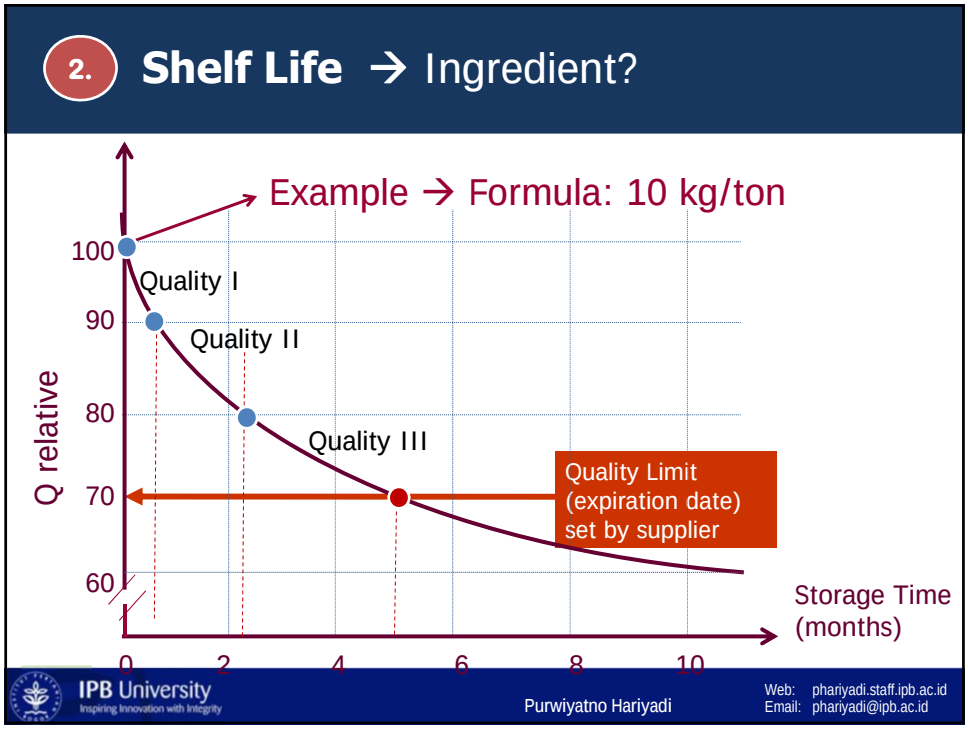
2.
Shelf Life → Ingredient?
Example → Formula: 10 kg/ton
100
90
80
70
60
Quality I
Quality II
Quality III
Q relative
Quality Limit
(expiration date)
set by supplier
Storage Time
(months)
0
2
4
6
8
10
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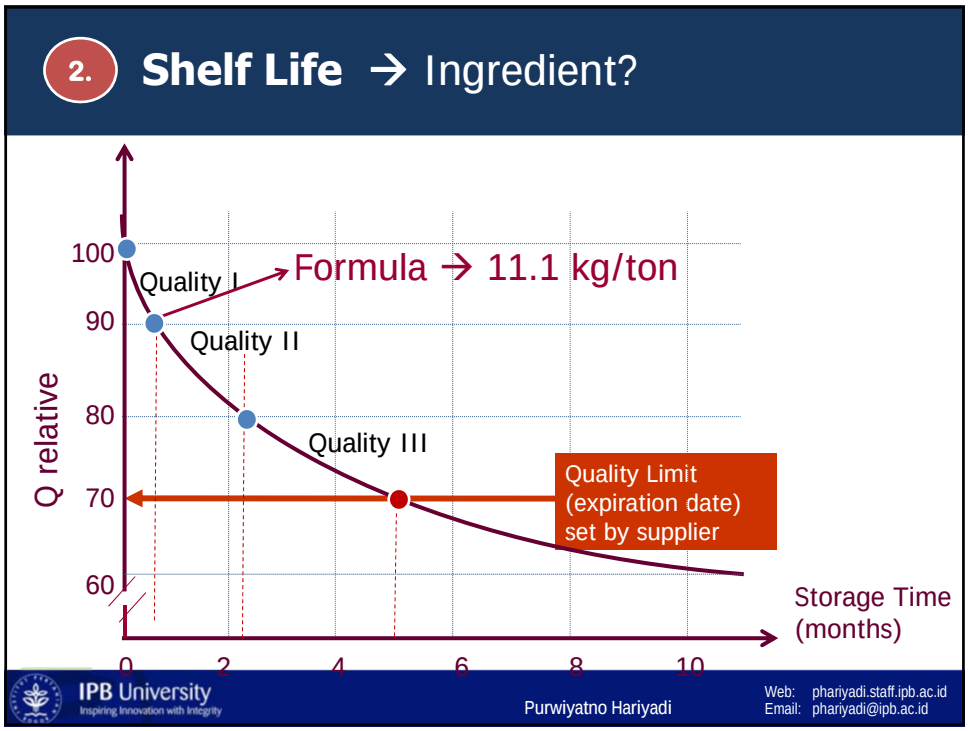
2.
Shelf Life → Ingredient?
Formula → 11.1 kg/ton
100
90
80
70
60
Quality I
Quality II
Quality III
Q relative
Quality Limit
(expiration date)
set by supplier
Storage Time
(months)
0
2
4
6
8
10
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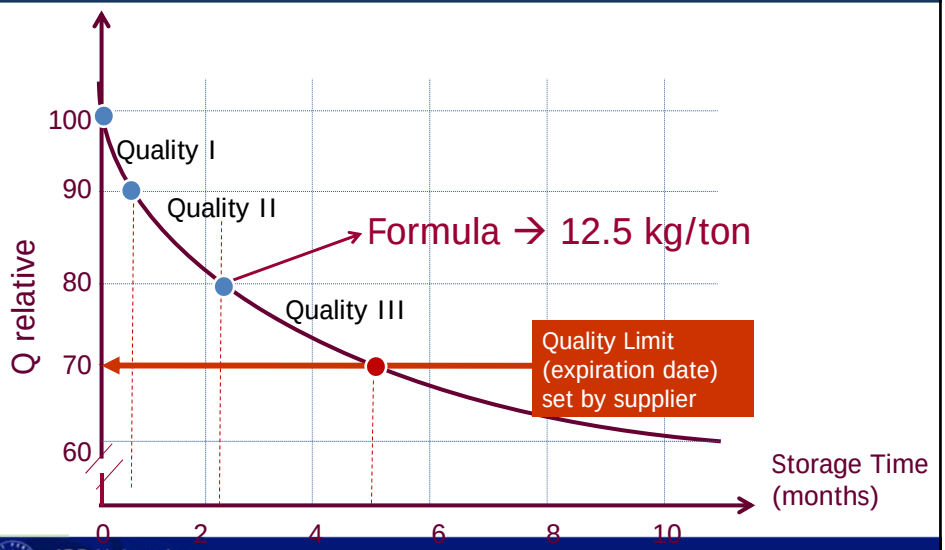

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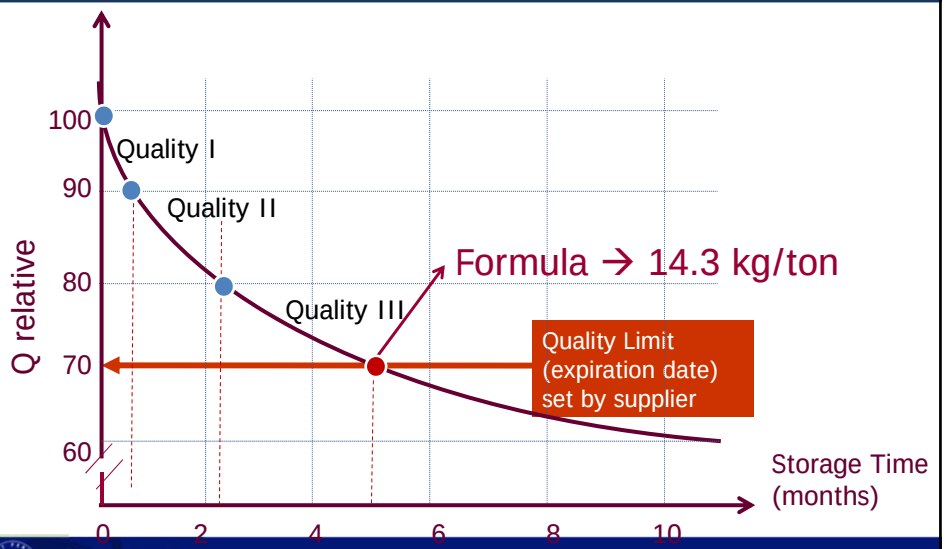

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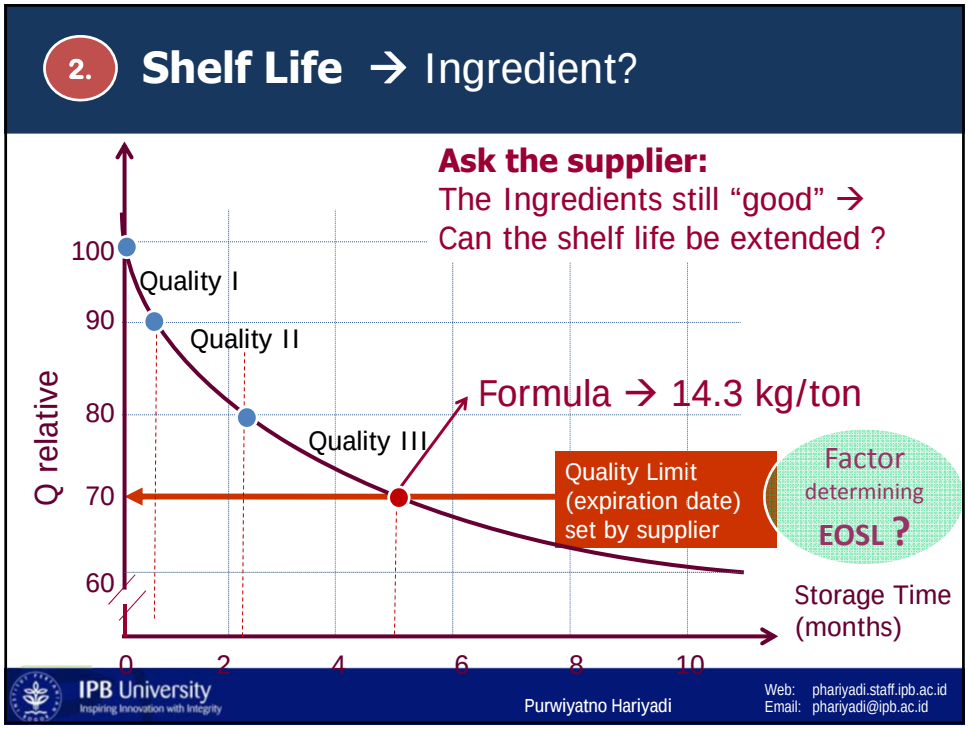
2.
Shelf Life → Ingredient?
Ask the supplier:
The Ingredients still "good" →
Can the shelf life be extended ?
Q relative
100
90
80
70
60
Quality I
Quality II
Quality III
Formula → 14.3 kg/ton
Quality Limit
(expiration date)
set by supplier
Factor
determining
EOSL ?
Storage Time
(months)
0
2
4
6
8
10
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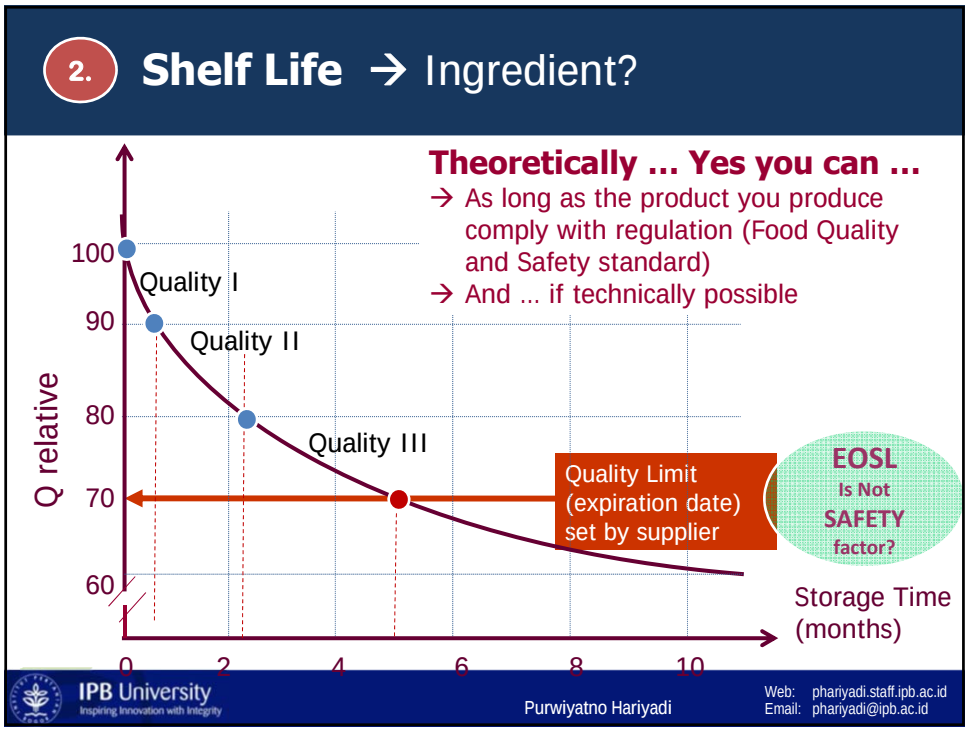
2.
Shelf Life → Ingredient?
Theoretically ... Yes you can ...
→ As long as the product you produce comply with regulation (Food Quality and Safety standard)
→ And ... if technically possible
Q relative
100
90
80
70
60
Quality I
Quality II
Quality III
Quality Limit
(expiration date)
set by supplier
EOSL
Is Not
SAFETY
factor?
Storage Time
(months)
0
2
4
6
8
10
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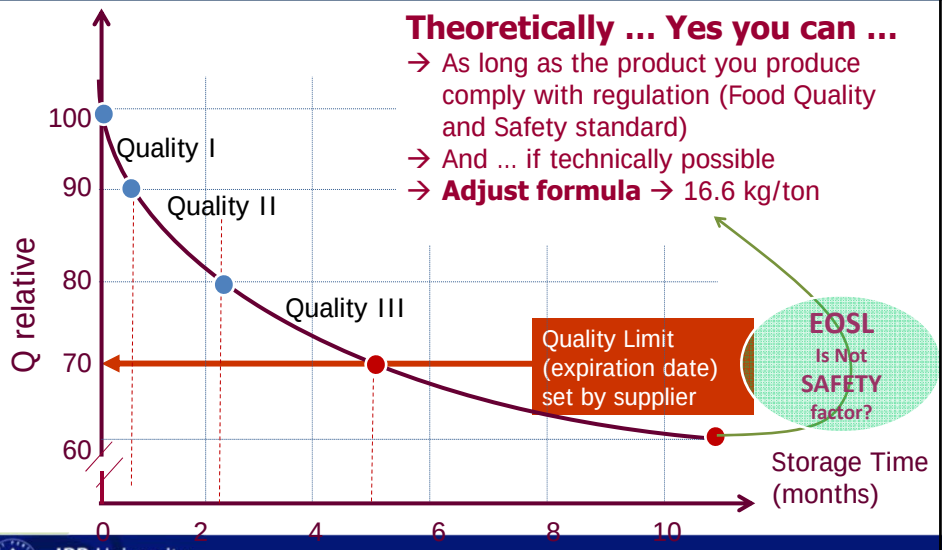

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2. Shelf Life → Ingredient?

→ Potential legal problem??

Food Law :

PRESIDEN
REPUBLIK INDONESIA

UNDANG-UNDANG REPUBLIK INDONESIA

NOMOR 18 TAHUN 2012

TENTANG

PANGAN

DENGAN RAHMAT TUHAN YANG MAHA ESA

PRESIDEN REPUBLIK INDONESIA,

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2. Shelf Life → Ingredient?

→ Potential legal problem??

Food Law :

Pasal 90

(1) Setiap Orang dilarang mengedarkan Pangan tercemar.

(2) Pangan tercemar sebagaimana dimaksud pada ayat (1) berupa Pangan yang:

a. mengandung bahan beracun, berbahaya, atau yang dapat membahayakan kesehatan atau jiwa manusia;

b. mengandung cemaran yang melampaui ambang batas maksimal yang ditetapkan;

c. mengandung bahan yang dilarang digunakan dalam kegiatan atau proses Produksi Pangan;

d. mengandung bahan yang kotor, busuk, tengik, terurai, atau mengandung bahan nabati atau hewani yang berpenyakit atau berasal dari bangkai;

e. diproduksi dengan cara yang dilarang; dan/atau

f. sudah kedaluwarsa.

2. Shelf Life → Ingredient?

→ Potential legal problem??

Food Law :

Pasal 99

Setiap Orang dilarang menghapus, mencabut, menutup, mengganti label, melabel kembali, dan/atau menukar tanggal, bulan, dan tahun kedaluwarsa Pangan yang diedarkan.

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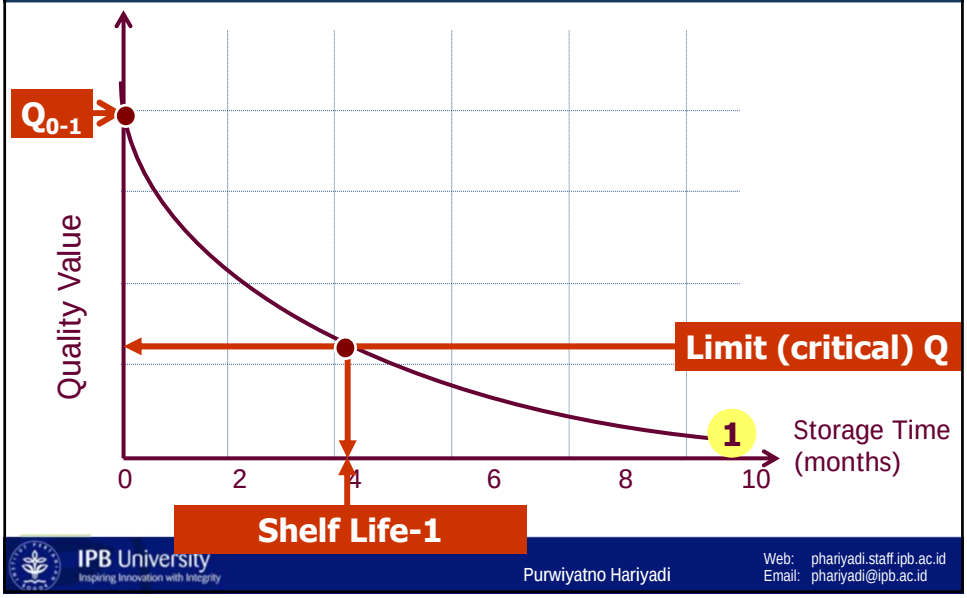
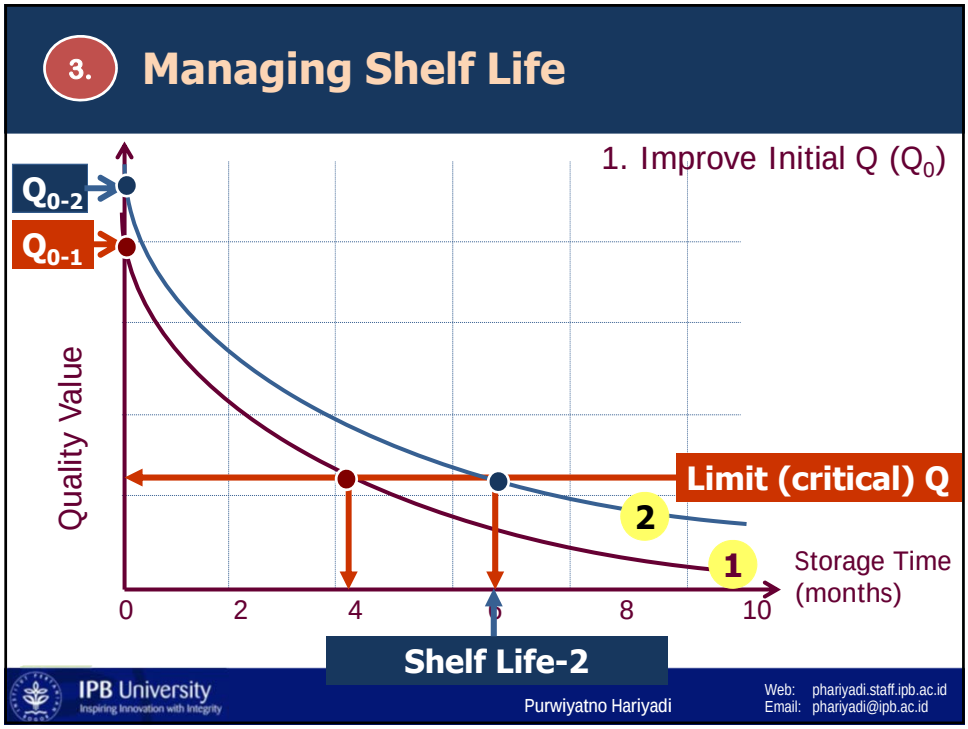
3. Managing Shelf Life

Shelf-life is established within "Design" and managed through all stations.

DESIGN	PROCURE	CONVERT	DISTRIBUTE	CUSTOMER	CONSUMER
Products Raw Materials Packaging Process Safety incl. HACCP and Allergens Quality Shelf-life incl. stor. & distr. conditions Regulatory compl. label-specs	Raw Materials Packaging materials Supplier certification HACCP	GMP HACCP Prerequisite programs Raw Mat's receiving QA testing Allergens Coding, labels	Storage & distr. conditions 1st in, 1st out Manage stocks, remaining shelf-life Warehouse Quality Manual	Storage & distr. conditions 1st in, 1st out Manage stocks, remaining shelf-life Warehouse Quality Manual	Storage conditions Prep. instructions Use within shelf-life Consumers behaviour
Develop, test, verify, specify (=>specs)	Purchase to specs	Finished product to specs	Handle and store to specs	Handle and store to specs	Handle and use to labels (ideally)

3. Managing Shelf Life




3.
Managing Shelf Life
1. Improve Initial Q (Q_0)
Q_{0-2}
Q_{0-1}
Quality Value
Limit (critical) Q
2
1
Storage Time (months)
0
2
4
8
10
Shelf Life-2
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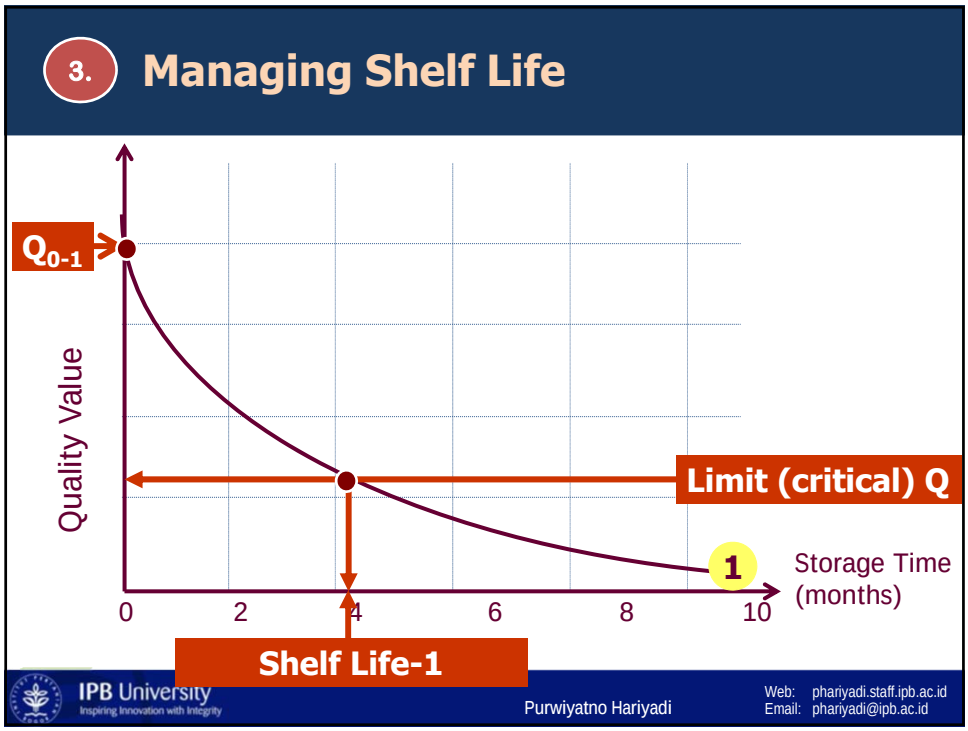
3.
Managing Shelf Life
Q_{0-1}
Quality Value
Limit (critical) Q
1
Storage Time (months)
0
2
4
6
8
10
Shelf Life-1
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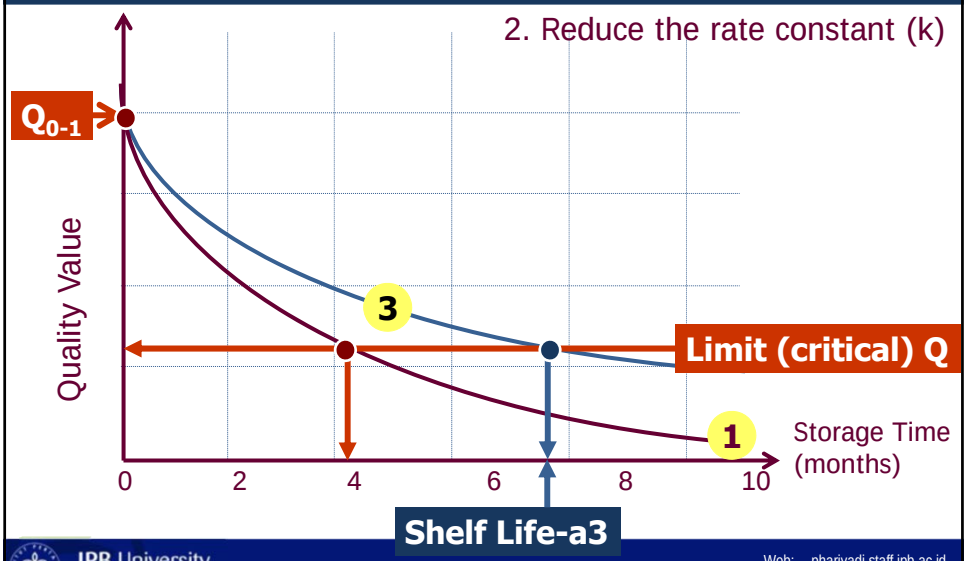
3. Managing Shelf Life



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Managing Shelf Life:

Identify weakes link ?

Quality

1. Product characteristics
2. Processing technology
3. Packaging
4. Condition of storage, distribution& handling

Shelf Life

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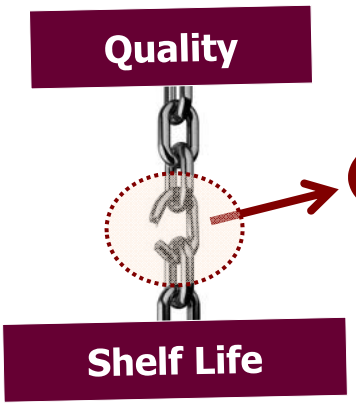
Managing Shelf Life:

= Shelf Life is determine by the weakest link

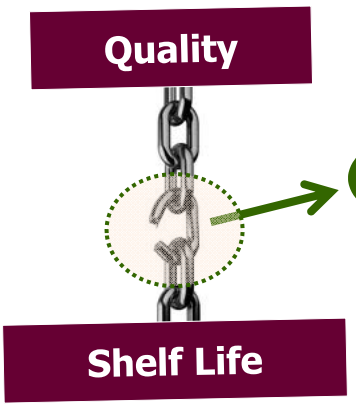


1 **Product characteristics (RM, ingredients)**

- nutrients, water (a_w), acids (pH), microbial load, etc

Managing Shelf Life:

= Shelf Life is determine by the weakest link



2 **Processing technology**

- Temp (T) & Time (t)
- Cleaning (4T)
- Hygienic practices. dll

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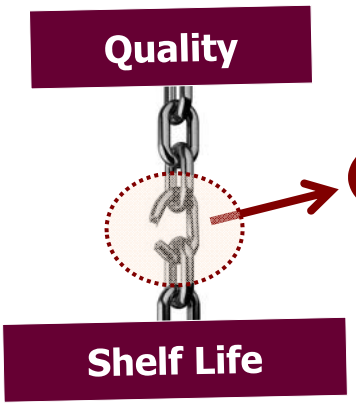


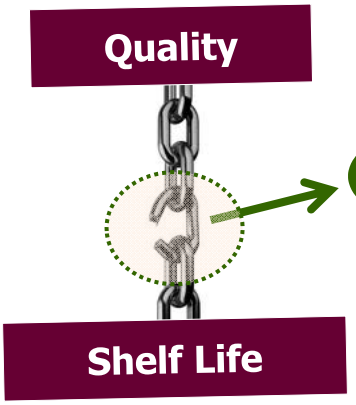
3

Packaging

- WVTR?
- OTR?
- Light protection ?
- Physical protection?

Managing Shelf Life:

= Shelf Life is determine by the weakest link



4

Condition of storage, distribution& handling

- T, RH, light?
- Handling practices?
- Transportation prcatices?
- Storage practices?

Managing Shelf Life:

= Shelf Life is determine by the weakest link

Responsibillity of food Industry: Optimizing Shelf Life

Quality

1. Product characteristics
2. Processing technology
3. Packaging
4. Condition of storage, distribution& handling

Shelf Life

Manage these factors

Assurance that "at possible latest consumption→ the characteristics of food product are remain acceptable"

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TERIMAKASIH

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