Ekivalensi proses termal: OPTIMASI PROSES TERMAL

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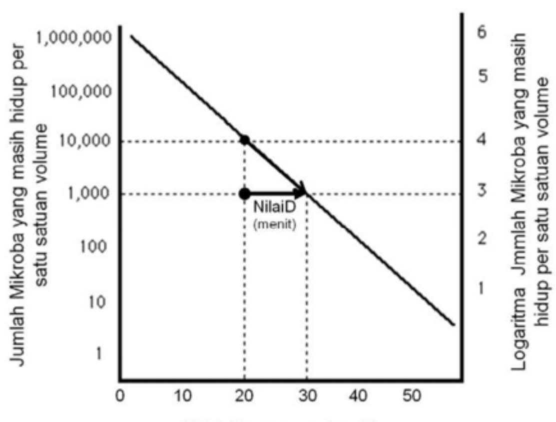
OPTIMASI PROSES PANAS– Kinetika Inaktivasi Mikroba

(2) Definisi Nilai D



OPTIMASI PROSES PANAS– Kinetika Inaktivasi Mikroba

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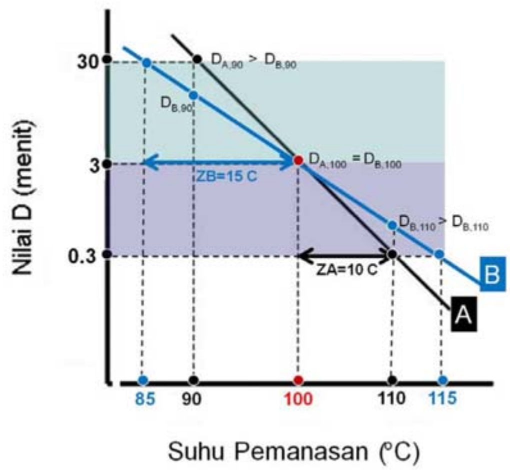

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OPTIMASI PROSES PANAS– Kinetika Inaktivasi Mikroba

Referensi ; *(Maroulis and Saravacos, 2003. Food Process Design. Thermal Destruction Data of Spoilage Microorganisms; p 312)*

Jenis Mikroba	T_R (°C)	D (min)	Z (°C)	D-Red	Produk
1. *C. Botulinum*	121	0,25	11	12	*LAFs (pH >4,5)*
2. *C. Sporogenes*	121	1,50	11	5	*Daging*
3. *B. Stearotherm.*	121	5,00	10	5	*Sayuran & susu*
4. *C. Thermosacch.*	121	4,00	11	5	*Sayuran*
5. *B. Subtilis*	121	0,40	7	6	*Susu & produk susu*
6. *B. Coagulan*	121	0,07	10	5	*4,2 <pH<4,5, tomat*
7. *C. pasteurianum*	100	0,50	8	5	*4,2 <pH<4,5, pir*

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OPTIMASI PROSES PANAS– Kinetika Inaktivasi Mikroba

Referensi ; *(Maroulis and Saravacos, 2003. Food Process Design. Thermal Destruction Data of Spoilage Microorganisms; p 312)*

Aspek Mutu (Nilai Tambah)	T_R (°C)	D (min)	Z (°C)
1. *Vitamin C*	121	931	17,8
2. *Tiamin*	121	254	25,4
3. *Vitamin A*	121	43,5	20,0
4. *KLorofil*	121	15,4	45,0
5. *Dll*	?	?	?

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OPTIMASI PROSES PANAS– Kinetika Inaktivasi Mikroba

Referensi ; *(Maroulis and Saravacos, 2003. Food Process Design. Thermal Destruction Data of Spoilage Microorganisms; p 312)*

	T_R (°C)	D (min)	Z (°C)	D-Red
Mikroba				
1. *Pathogenik*	75	0,01	9,5	12
2. *Mesofilik*	120	0,15	10,0	9
3. *Thermofilik*	120	0,50	10,5	9
Aspek Mutu (nilai Tambah				
1. *Tiamin*	120	120	30	
2. *Lisin*	120	960	20	
3. *Asam Askorbat*	120	960	18	

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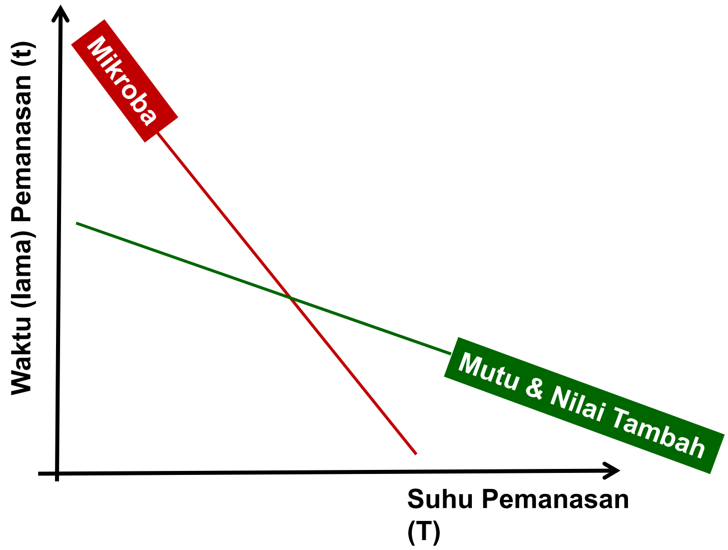
OPTIMASI PROSES PANAS– Kinetika Inaktivasi Mikroba



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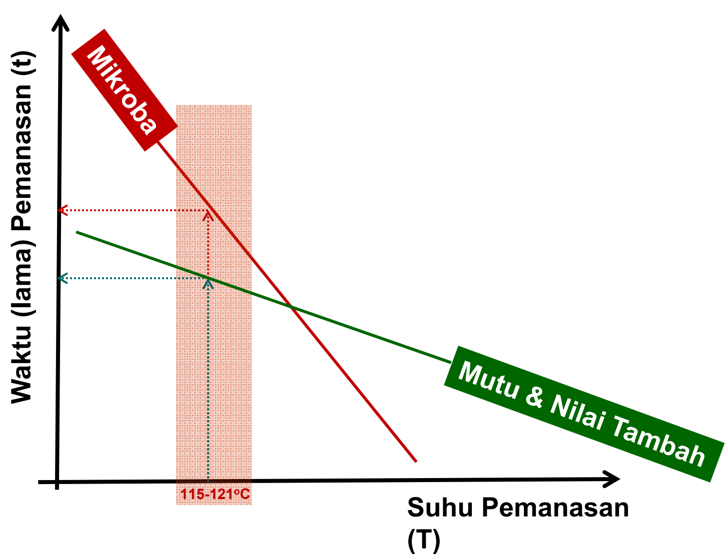
OPTIMASI PROSES PANAS– Kinetika Inaktivasi Mikroba



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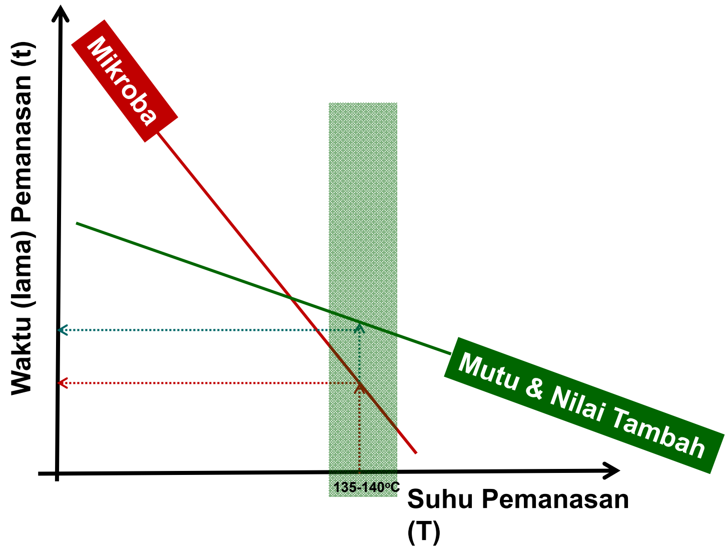
OPTIMASI PROSES PANAS– Kinetika Inaktivasi Mikroba



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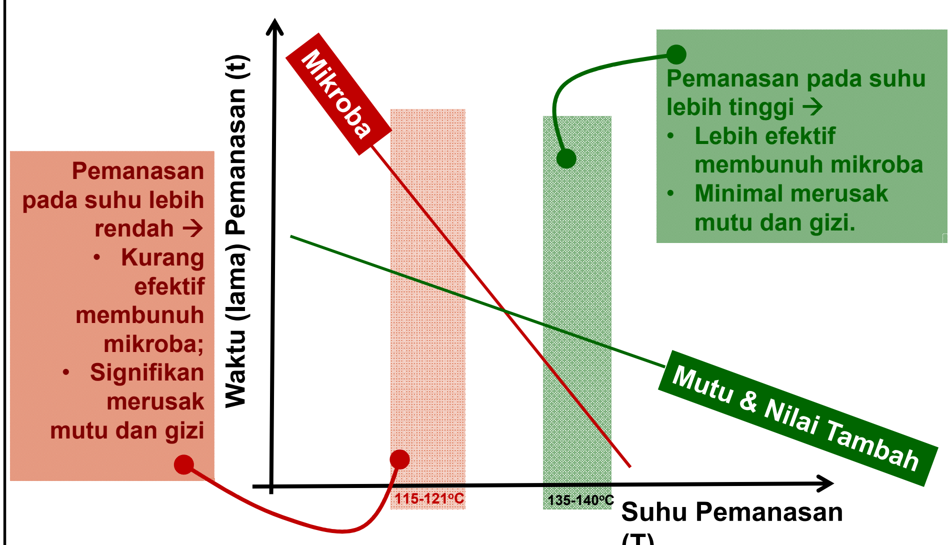
OPTIMASI PROSES PANAS– Kinetika Inaktivasi Mikroba



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OPTIMASI PROSES PANAS– LATIHAN

PR 1. B.

Proses pemanasan (sterilisasi) akan dilakukan dengan persyaratan Perka BPOM tentang Pangan Steril Komerisal (Fo $\geq$ 3.0 menit; target *C. botulinum*). Produk yang diproses adalah produk dengan vitamin C sebagai kandungan gizi utama. Diketahui bahwa Vitamin C akan mengalami degradasi karena panas, dengan pola degradasi mengikuti model reaksi ordo 1 ($k_{121°C}$ =0.002menit^{-1} dan E_a=164.3 kJ/mol).

Tentukan kombinasi T (suhu) dan t (waktu) pemanasan untuk memenuhi persyaratan Perka BPOM tsb, tetapi tidak menyebabkan 5 persen kerusakan vitamin C.

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OPTIMASI PROSES PANAS– LATIHAN

PR 1. B.

***C botulinum*:**

Nilai Fo = LR.t
Jadi;
jika diinginkan
nilai Fo = 3 menit, maka:

T [C]	LR	t (min)
70	0.0000	386474.866
80	0.0001	38647.487
90	0.0008	3864.749
100	0.0078	386.475
105	0.0245	122.214
110	0.0776	38.647
115	0.2455	12.221
121	0.9772	3.070
125	2.4547	1.222
130	7.7625	0.386
140	77.6247	0.039

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OPTIMASI PROSES PANAS– LATIHAN

PR 1. B.

VIT C:

Penurunan VitC dapat dinyatakan dengan:
- d[VitC] / dt = k [VitC]
d[VitC]/[VitC] = - k dt
ln [VitC] = ln $[VitC]_0$ – kt
ln ($[VitC]_0$/[VitC]) = kt

→ t_T = [ln(100/95)]/k_T

ln k_T = ln k_0 - (Ea/R)(1/T)
k_T = EXP [ln k_0 - (Ea/R)(1/T)]
Pada suhu T=121°C=394°K
k_{121C}=k_{394K}=0.002 menit^{-1}, Ea = 164.3 kJ.mol, R = 0.008314 kJ/mol
→ ln k_0 = 43.942
k_T = EXP [43.942 - (164.3/0.008314)(1/T)]

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OPTIMASI PROSES PANAS– LATIHAN

PR 1. B.

VIT C:

→ t_T = [ln(100/95)]/k_T
→ k_T = EXP [ln k_0 - (Ea/R)(1/T)]
→ k_T = EXP [43.942 - (164.3/0.008314)(1/T)]

T(°K)	1/T	ln ko	Ea/R	k_T	ln(100/95)	t=? Menit
343	0.002915	43.94237	19761.84749	1.15E-06	0.0512933	44451.556
353	0.002833	43.94237	19761.84749	5.9E-06	0.0512933	8690.713
363	0.002755	43.94237	19761.84749	2.76E-05	0.0512933	1858.994
373	0.002681	43.94237	19761.84749	0.000119	0.0512933	431.930
378	0.002646	43.94237	19761.84749	0.000239	0.0512933	214.318
383	0.002611	43.94237	19761.84749	0.000474	0.0512933	108.305
388	0.002577	43.94237	19761.84749	0.000921	0.0512933	55.703
394	0.002538	43.94237	19761.84749	0.002	0.0512933	25.647
398	0.002513	43.94237	19761.84749	0.003311	0.0512933	15.492
403	0.002481	43.94237	19761.84749	0.006131	0.0512933	8.367
413	0.002421	43.94237	19761.84749	0.020098	0.0512933	2.552

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OPTIMASI PROSES PANAS– LATIHAN

PR 1. B.

VIT C & C. *botulinum*

T [C]	t, Fo=3, [=]menit	t, 5%, [=] menit
70	386474.8655	44451.55562
80	38647.48655	8690.713464
90	3864.748655	1858.993955
100	386.4748655	431.9301537
105	122.2140833	214.3176669
110	38.64748655	108.3051334
115	12.22140833	55.70311935
121	3.069878977	25.64664719
125	1.222140833	15.49198302
130	0.386474866	8.366887334
140	0.038647487	2.552183292

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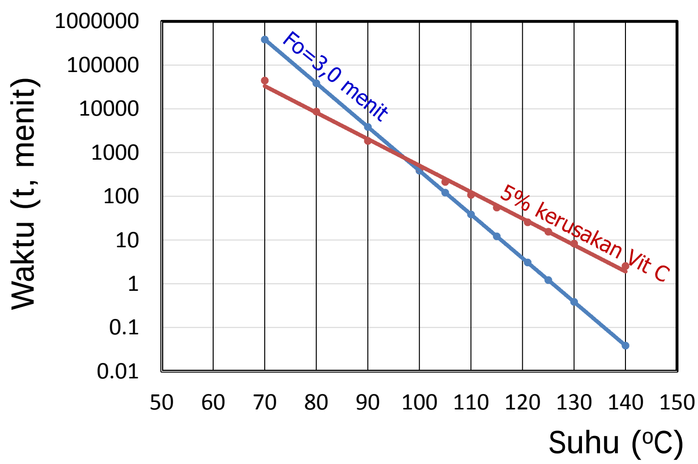
OPTIMASI PROSES PANAS– LATIHAN

PR 1. B.

VIT C & C. *botulinum*



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Kecukupan Panas UHT

10.7.2010 EN Official Journal of the European Union L 175/1

II

(Non-legislative acts)

REGULATIONS

COMMISSION REGULATION (EU) No 605/2010

of 2 July 2010

laying down animal and public health and veterinary certification conditions for the introduction into the European Union of raw milk and dairy products intended for human consumption

(Text with EEA relevance)

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Kecukupan Panas UHT

10.7.2010 EN Official Journal of the European Union L 175/1

II

(Non-legislative acts)

REGULATIONS

COMMISSION REGULATION (EU) No 605/2010

(a) a sterilisation process, to achieve an F_0 value equal to or greater than three; or

(b) an ultra high temperature (UHT) treatment at not less than 135 °C in combination with a suitable holding time.

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Kecukupan Panas UHT

10.7.2010 EN Official Journal of the European Union L 175/1

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Kecukupan Panas UHT

1. Definisi Nilai F_0

$$F_o = \frac{t}{60} \cdot 10^{\frac{(T-121.1)}{z}}$$

t = heating time, seconds

T = heating temperature, °C

z = the increase in temperature necessary for obtaining the same effect in one tenth of the time

F_o = 1 when heated one minute at 121.1°C

Malmgren, B, 2011. Aseptic process. External Partners Workshop, Singapore, 10-11 May 2011

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Kecukupan Panas UHT

2. Definisi Nilai Pemasakan (C-value)

$$C = \frac{t}{60} \cdot 10^{\frac{(T-100)}{z}}$$

t = heating time, seconds
T = heating temperature, °C
z = the increase in temperature necessary for obtaining the same effect in one tenth of the time

Malmgren, B, 2011. Aseptic process. External Partners Workshop, Singapore, 10-11 May 2011

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Kecukupan Panas UHT

3. Definisi Nilai B*

$$B^* = \frac{t}{10.1} \cdot 10^{\frac{(T-135)}{10.5}}$$

Assumption:
commercial sterility is achieved at B* = 1
(heat treatment at 135 °C for 10.1 sec., z = 10.5)
= reduction of thermophilic spores = 10^9

Malmgren, B, 2011. Aseptic process. External Partners Workshop, Singapore, 10-11 May 2011

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Kecukupan Panas UHT

4. Definisi Nilai C*

$$C^* = \frac{t}{30.5} \cdot 10^{\frac{(T-135)}{31.4}}$$

C* = 1 – heat treatment
to 135 °C for 30.5 sec., z = 31.4 °C
= **destruction of thiamin for 3 %**

Malmgren, B, 2011. Aseptic process. External Partners Workshop, Singapore, 10-11 May 2011

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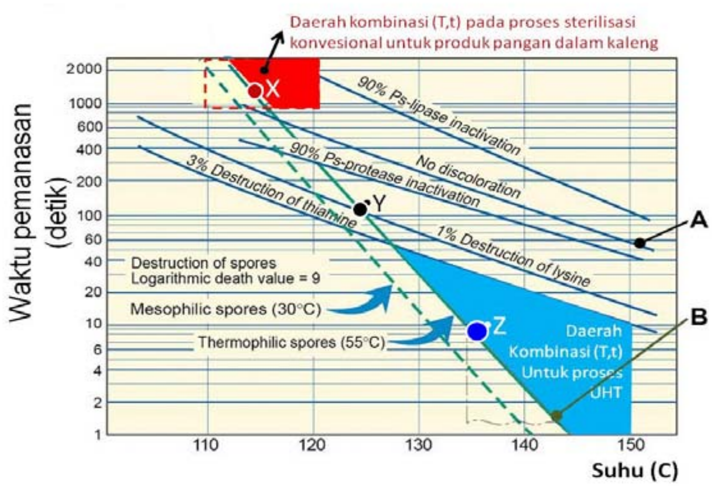
Kecukupan Panas UHT



Faktor Mutu susu Steril UHT

- *Colour*
- *Smell*
- *Taste*
- *Texture*
- *Stability*

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Potensi **Permasalahan** Teknologi UHT

- Case of Non-Sterility

Int. Dairy Journal **8** (1998) 851–855

Printed in Great Britain
0958-6946/99/$ - see front matter
PII: S0958-6946(98)00129-0

ELSEVIER

Thermal Death Kinetics of Spores of *Bacillus sporothermodurans* Isolated from UHT Milk

Ingrid A. Huemer*, Nicolette Klijn, Henri W. J. Vogelsang and Leo P. M. Langeveld

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(Received 7 August 1998; accepted 26 November 1998)

ABSTRACT

In recent years reports have been published on non-sterility problems in UHT milk caused by the survival of very heat-resistant spores, which have been identified as belonging to the species *Bacillus sporothermodurans*. In order to solve the problems in dairy practice more information is needed on the thermal death kinetics of these spores. The heat resistance of spores of three *Bacillus sporothermodurans* strains isolated from non-sterile UHT milk was determined in the temperature range of 110–145°C and was compared with the heat resistance of *Bacillus stearothermophilus* spores. For the low temperatures (110–125°C) the heating was carried out in tubes. For the higher temperatures (130–145°C) a direct UHT sterilizer was used. D_{140} values of 3.4–7.9 s (*B. stearothermophilus* $D_{140} = 0.9$ s) indicate an exceptionally high heat resistance of spores of *B. sporothermodurans* under UHT conditions. Thermal death time (TDT) curves show different slopes for *B. sporothermodurans* and *B. stearothermophilus*, with $z = 13.1–14.2$°C and 9.1°C, respectively. To our knowledge there are no observations of other spores in the literature for which such high D_{140} values and z values have been demonstrated.

Keywords: heat resistance; *Bacillus sporothermodurans*; spores TDT curve

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Potensi **Permasalahan** Teknologi UHT

- Case of Non-Sterility

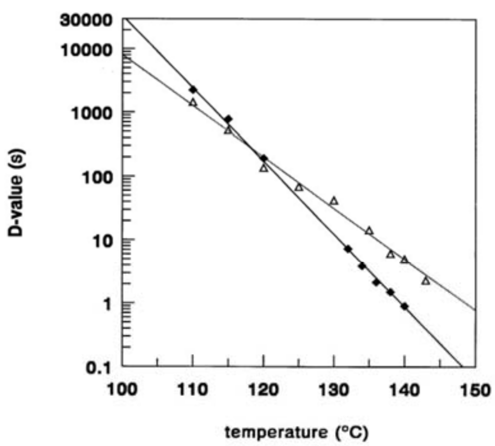

Fig. 2. Thermal death time curves of *B. stearothermophilus spores* (◆) and *B. sporothermodurans spores* J16[B] (△); best fit lines through experimental data.

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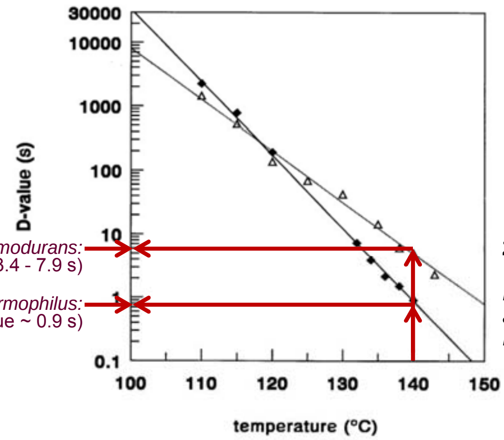
Potensi **Permasalahan** Teknologi UHT

- Case of Non-Sterility

B. Sporothermodurans:
D_{140}-value ~ 3.4 - 7.9 s)

B. Stearothermophilus:
D_{140}-value ~ 0.9 s)



Zvalue:

B. Sporothermodurans: 13.1-14.2ºC
and
B. Stearothermophilus: 9.1ºC

Fig. 2. Thermal death time curves of *B. stearothermophilus spores* (◆) and *B. sporothermodurans spores* J16[B] (△); best fit lines through experimental data.

Potensi **Permasalahan** Teknologi UHT

- Case of Non-Sterility

Factors? → Cleaning

"4T" law: the success of CIP depends on:

1. **the correct cleaning Time**
2. **the right Temperature**
3. **the Turbulence**
4. **the Titration of cleaning solution**

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Potensi **Permasalahan** Teknologi UHT

- Case of Non-Sterility

Factors?

→ **Reprocessing of UHT milk.**

→ **Waiting time (delay of processing) at warm temperature**

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Potensi **Permasalahan** Teknologi UHT

- Case of Gelation

IChemE

0960–3085/00/$10.00+0.00
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Trans IChemE, Vol 79, Part C, December 2001

AGE GELATION OF UHT MILK—A REVIEW

N. DATTA and H. C. DEETH
Dairy Industry Centre for UHT Processing, School of Land and Food Sciences, University of Queensland, Australia

Gelation of UHT milk during storage (age gelation) is a major factor limiting its shelf-life. The gel which forms is a three-dimensional protein matrix initiated by interactions between the whey protein β-lactoglobulin and the κ-casein of the casein micelle during the high heat treatment. These interactions lead to the formation of a β-lactoglobulin–κ-

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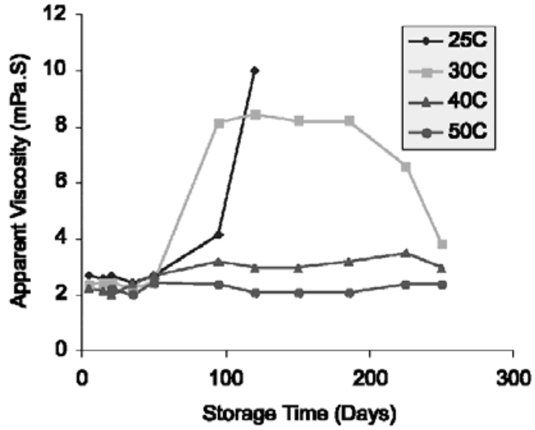
Potensi **Permasalahan** Teknologi UHT

- Case of Gelation



In general,
gelation occurs more readily at room temperatures (~20–25°C) than at low (~4°C) and high (~35–40°C)

Age gelation of UHT Milk (Kocak, H. R. and Zadow, J. G., 1985, Age gelation of UHT whole milk as in uenced by storage temperature, *Aust J Dairy Technol,* 40(1): 14–21)

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Potensi **Permasalahan** Teknologi UHT

- Case of Gelation

AGE GELATION OF UHT MILK—A REVIEW 199

Table 1. Effect of preheating and sterilization conditions on gelation time of UHT milk[5,7,9–11].

	Sterilization conditions			
Preheating conditions	Temp, °C	Time, s	Storage temperature, °C	Time to gelation, days
Nil	140[5]	3	30	96–99
72°C/30 s	140[5]	3	30	110–113
80°C/30 min	140[5]	3	30	117–120
30°C/4hr	140[5]	3	30	96–99
	135[5]	3	30	96–99
	140[5]	2	30	96–99
	140[5]	3	30	96–99
	140[5]	5	30	117–120
	145[5]	3	30	110–113
70°C/10 s	142 (direct)[7]	5	25	84–98
75°C/10s	145 (indirect)[7]	3	25	No gelation up to 182 days
Nil	Direct process[9]		20	42–70
Nil	142 (direct)[10]	6		150
Nil	152 (direct)[10]	6		214
60°C/10 min	130 (direct)[11]	2	21	150
	140 (direct)[11]	2	21	180
	150 (direct)[11]	2	21	No gelation

For data from Zadow and Chituta[5], milk processed by steam injection (direct); for data from Manji *et al.*[7], McKellar *et al.*[9] and Samuelson and Holm[10], milk processed by steam infusion (Dasi, direct); for data from Attia *et al.*[11], milk processed by direct heating (Elecster 2000).

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Potensi **Permasalahan** Teknologi UHT

- Case of Gelation

Gelasi (penggumpalan) pada susu UHT selama penyimpanan erat berkaitan dengan reaksi proteolisis.

(i) protease alami pada susu (plasmin)
(ii) proteinase yg diproduksi oleh bakteri psikrotrop (kontaminant) → protease ekstraseluler.

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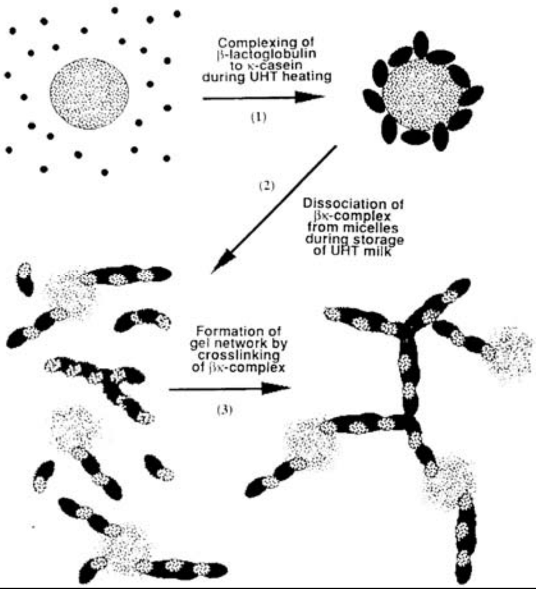
Potensi **Permasalahan** Teknologi UHT

- Case of Gelation



Potensi **Permasalahan** Teknologi UHT

- Case of Gelation

Table 5. Effect of psychrotrophic bacteria count in raw milk on gelation time of UHT milk.

Bacterial count $cfu^{-1} ml^{-1}$	Gelation time, days	Reference
$< 8.0 \times 10^6$	> 140	Law, B. A., Andrews, A. T. And Sharpe,M. E., 1977, Gelation of ultrahigh temperature-sterilized milk by proteinases from a strain of *Pseudomonas uorescens isolated from raw milk, J Dairy Res,* 44(1): 145–148.
8.0×10^6	~ 63	
5.0×10^7	~ 12	

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Potensi **Permasalahan** Teknologi UHT

- Case of Gelation

Proteolysis	*Milk Proteinase*	*Bacterial Proteinase*
Occurrence in	UHT-sterilized milk products	UHT-sterilized milk products
Defects	Bitter off-flavor Transparency of skim milk Glassy appearance of low-fat custard Destabilization	Bitter off-flavor Gelation Separation of whey
Prevention	Sterilization treatment sufficiently high, e.g., 16 s at 142°C	Manufacture of milk of good bacteriological quality Cold storage (<4°C) of the milk for a maximum 3 days at the farm and 1 day at the factory; if not, a thermization treatment of the milk has to be applied Prevention of contamination of the thermized milk Effective cleaning of processing lines

Source: Reprinted with permission from F.M. Driessen, Inactivation of Lipases and Proteases, *Heat Induced Changes in Milk*, IDF Bulletin No. 238, pp. 71–93, © 1989, International Dairy Federation.

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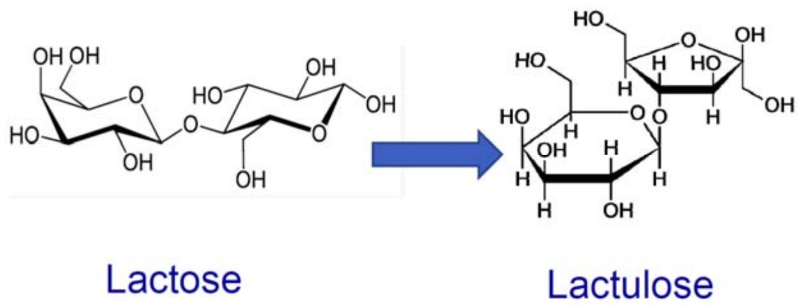
Potensi **Permasalahan** Teknologi UHT
- Lactulose

- Tingkat/intensitas pemanasan yang diterima oleh susu dan produk-produk susu → laktulosa sebagai indikator.



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Potensi **Permasalahan** Teknologi UHT
- Lactulose

- Laktulosa secara alami tidak terdapat pada susu segar; terbentuk selama proses pemanasan; sebagai hasil isomerisasi dari laktosa → khas pada susu
- The European Union (EU) : indikator untuk menentukan intensitas pemanasan susu, untuk membedakan antara susu pasteurisasi, susu steril dalam wadah, atau pu susu steril-UHT

(EU Milk Hygiene Directive, 1992).

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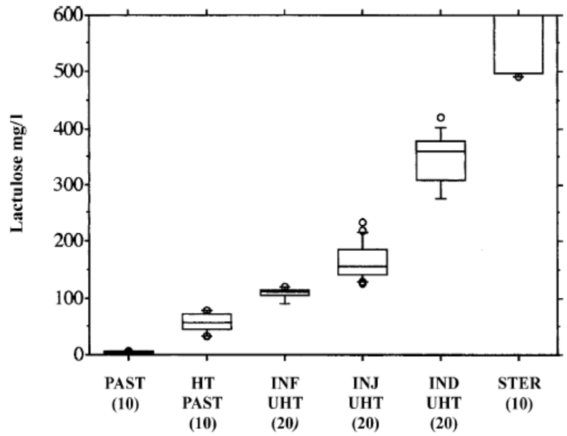
Potensi **Permasalahan** Teknologi UHT
- Lactulose

Lactulose contents in milks of different heat-processes:

- PAST=fresh pasteurized milk;
- HT PAST=high temperature
- pasteurized milk;
- IND UHT=indirect UHT-treated
- milk;
- INJ UHT=direct UHT-treated milk using an injection system;
- INF UHT=direct UHT-treated milk using an infusion system;
- STER=In-container sterilized milk.

() Number of samples per class.



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TERIMAKASIH

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