

ITP730

Thermal Processing of Foods

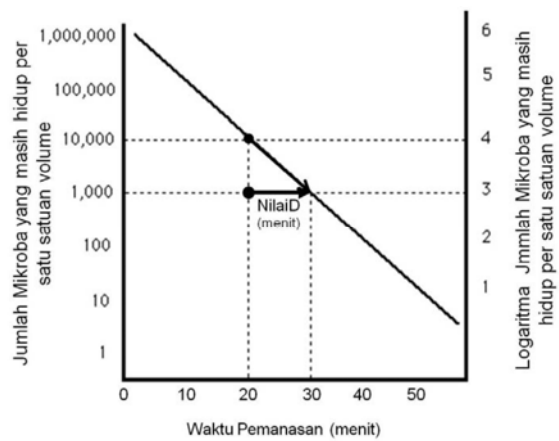
OPTIMASI PROSES TERMAL

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OPTIMASI PROSES PANAS– Kinetika Inaktivasi Mikroba

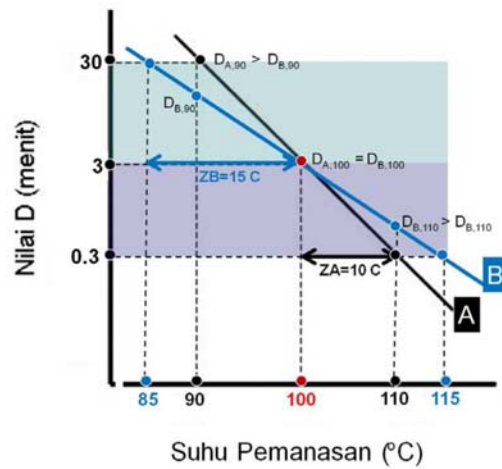
(2) Definisi Nilai D



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OPTIMASI PROSES PANAS– Kinetika Inaktivasi Mikroba

(2) Definisi Nilai z



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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. <i>C. Botulinum</i>	121	0,25	11	12	LAFs (pH >4,5)
2. <i>C. Sporogenes</i>	121	1,50	11	5	Daging
3. <i>B. Stearotherm.</i>	121	5,00	10	5	Sayuran & susu
4. <i>C. Thermosacch.</i>	121	4,00	11	5	Sayuran
5. <i>B. Subtilis</i>	121	0,40	7	6	Susu & produk susu
6. <i>B. Coagulan</i>	121	0,07	10	5	4,2 <pH<4,5, tomat
7. <i>C. pasteurianum</i>	100	0,50	8	5	4,2 <pH<4,5, pir

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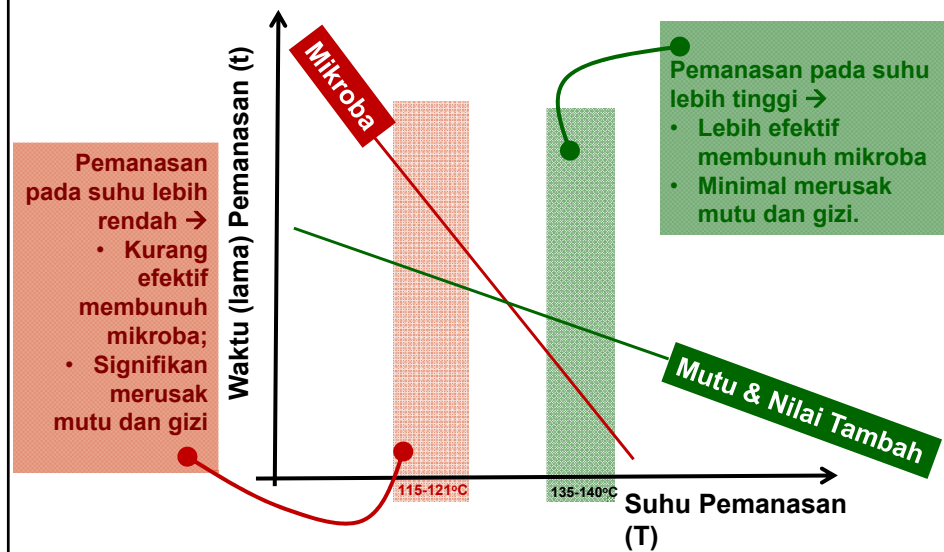
OPTIMASI PROSES PANAS– Kinetika Kerusakan Mutu

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. DII	?	?	?

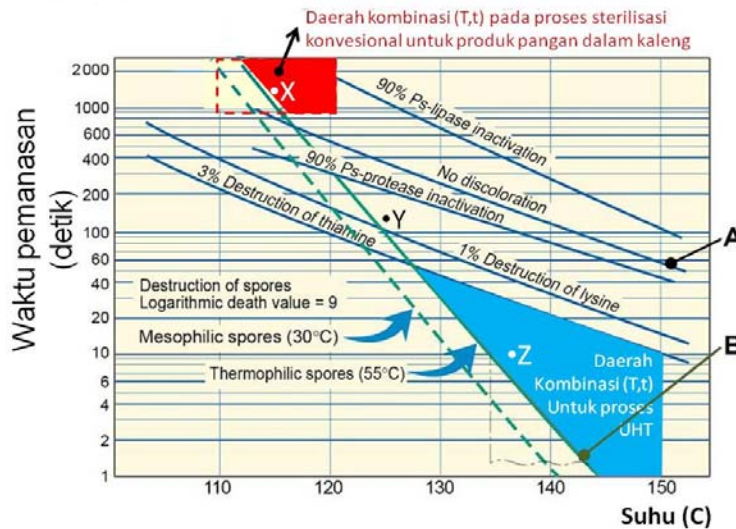
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OPTIMASI PROSES PANAS– Kinetika Inaktivasi Mikroba Vs Kerusakan Mutu



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**OPTIMASI PROSES PANAS—
Kinetika Inaktivasi Mikroba Vs Kerusakan Mutu**



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**OPTIMASI PROSES PANAS—
Ukuran 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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OPTIMASI PROSES PANAS— Ukuran Kecukupan Panas UHT

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(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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OPTIMASI PROSES PANAS— Ukuran Kecukupan Panas UHT

1. Definisi Nilai F_0

$$F_0 = \frac{t}{60} \cdot 10^{\frac{(T-121.1)}{z}}$$

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

$F_0 = 1$ 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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OPTIMASI PROSES PANAS–

Ukuran 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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OPTIMASI PROSES PANAS–

Ukuran 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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OPTIMASI PROSES PANAS–

Ukuran Kecukupan Panas UHT

4. Definisi Nilai C*

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

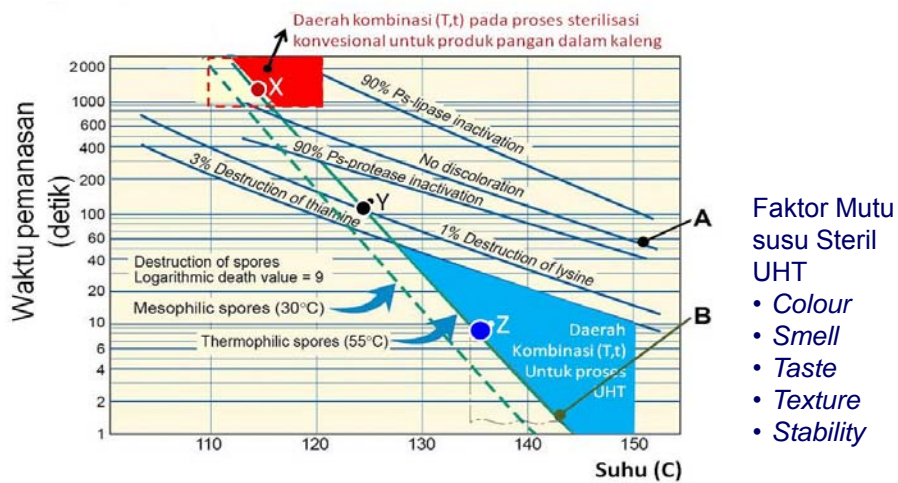
$C^* = 1$ – heat treatment
to 135 °C for 30.5 sec., $z = 31.4$ °C
= **destruction of thiamin for 3 %**

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

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OPTIMASI PROSES PANAS–

Ukuran Kecukupan Panas UHT



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Potensi Permasalahan Teknologi UHT - Case of Non-Sterility



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

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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. © 1999 Published by Elsevier Science Ltd. All rights reserved

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

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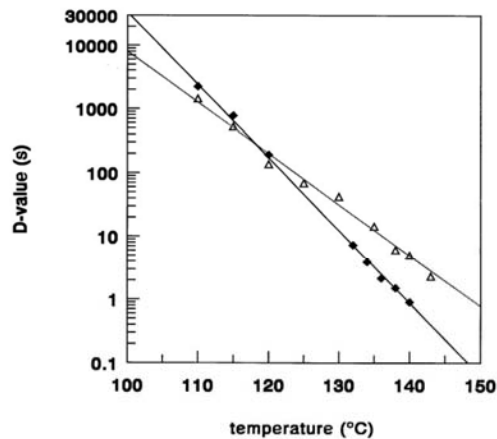


Fig. 2. Thermal death time curves of *B. stearothermophilus* spores (◆) and *B. sporothermodurans* spores J16^B (△); best fit lines through experimental data.

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Potensi **Permasalahan** Teknologi UHT - Case of Non-Sterility

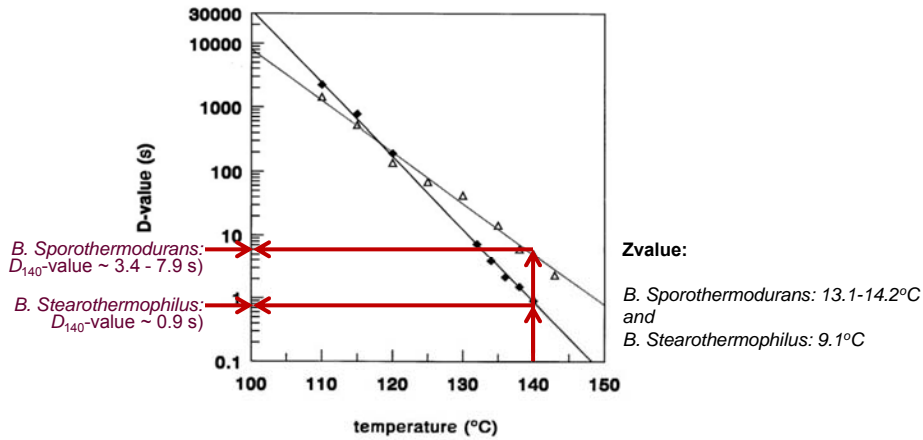


Fig. 2. Thermal death time curves of *B. stearothermophilus* spores (◆) and *B. sporothermodurans* spores J16^B (△); best fit lines through experimental data.

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Potensi **Permasalahan** Teknologi UHT - Case of Gelation

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Trans IChemE, Vol 79, Part C, December 2001

AGE GELATION OF UHT MILK—A REVIEW

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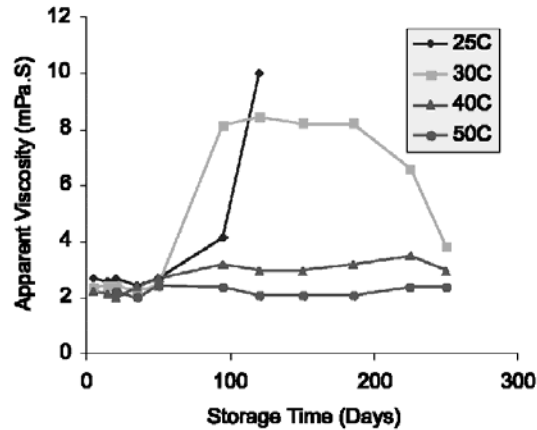
Gelation of UHT milk during storage (age gelation) is a major factor limiting its shelf-life. The gel which forms is a three-dimensional protein matrix initiated by interactions between the whey protein β -lactoglobulin and the κ -casein of the casein micelle during the high heat treatment. These interactions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

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

Preheating conditions	Sterilization conditions		Storage temperature, °C	Time to gelation, days
	Temp, °C	Time, s		
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/10 s	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 Chituta⁵, milk processed by steam injection (direct); for data from Manji *et al.*⁷, McKellar *et al.*⁹ and Samuelson and Holm¹⁰, 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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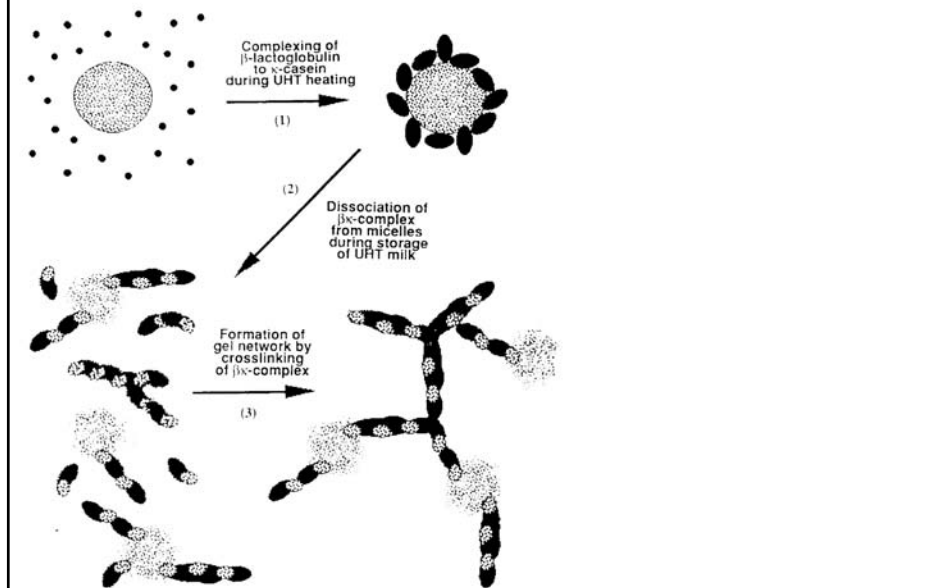
Potensi **Permasalahan** Teknologi UHT - Case of Gelation

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

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

Bacterial count $\text{cfu}^{-1} \text{ml}^{-1}$	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 <i>Pseudomonas uorescens</i> isolated from raw milk, <i>J Dairy Res</i> , 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

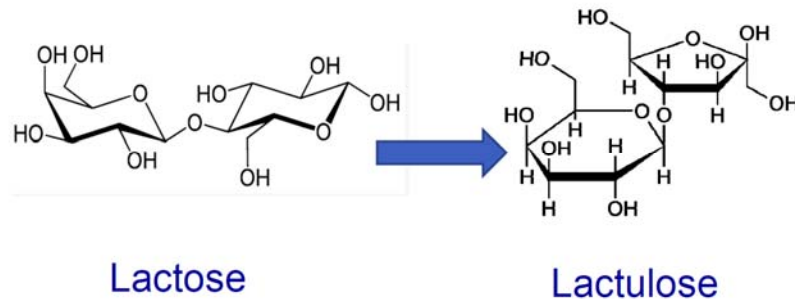
	Proteolysis	Milk Proteinase	Bacterial Proteinase
Occurrence in	UHT-sterilized milk products	UHT-sterilized milk products	UHT-sterilized milk products
Defects	Bitter off-flavor Transparency of skim milk Glassy appearance of low-fat custard Destabilization	Bitter off-flavor Gelation Separation of whey	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 ($< 4^\circ\text{C}$) 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	Manufacture of milk of good bacteriological quality Cold storage ($< 4^\circ\text{C}$) 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).

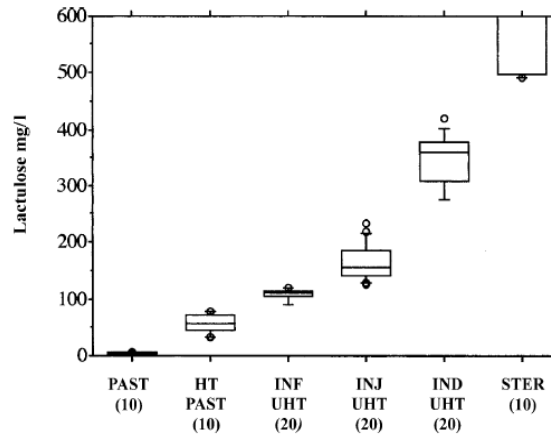
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Potensi Permasalahan Teknologi UHT - Lactulose

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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