Dairy Thermodurics

Module 2: Thermoduric Bacteria: The Raw Milk Connection

Content

- Incidence of thermoduric bacteria in raw milk: An overview
- Types of Thermodurics

Overview

- Seasonal variations have been noticed in total aerobic spore counts in raw milk
  - Usually a higher incidence is observed in the winter period, when cows are housed indoors
- Generally, the average counts are in the range of 10–100 cfu/mL
  - *Bacillus licheniformis* generally predominates in raw milk
- *Bacillus cereus* is the other most common psychrotolerant species, encountered especially in the summer period
  - Has a potential of food borne-intoxication and enzymatic spoilage

(Waes 1976; Phillips and Griffiths 1986; Sutherland and Murdoch 1994; te Giffel et al. 2002; Heyndrickx and Scheldeman 2002*)*

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Bacterial counts permissible in US milk

Milk	Test	Limits (cfu)
Grade A Raw Milk (Producer Milk)	Total Bacterial Counts	< 100,000/mL
Grade A Raw Milk (Commingled Milk)	Total Bacterial Counts	< 300,000/mL
	Somatic Cell Counts	< 750,000/mL
	Drugs	No drug residues detection
Grade A Pasteurized Milk	Total Bacterial Counts	20, 000/mL
	Coliforms	< 10/mL

(FDA Pasteurized Milk Ordinance. 2011)

Bulk tank storage

Total Bacteria Counts (TBC) Starting counts = 5,000 cfu/mL		
Storage Temperature (°C)/(°F)	48 Hours	72 Hours
2/ 35.6	5,000	15,000
4/ 39.2	10,000	30,000
6/ 42.8	30,000	100,000

- Imperative to maintain low holding temperatures in the bulk tank and other storage containers
- Thermoduric psychotrotolerant bacteria can grow even at low refrigeration temperatures (7°C/ 44.6°F or below)

(Murphy et al. 2007)

Types of thermodurics

Growth temperature based classification

- Thermodurics can be divided in to three sub groups based on their temperature of growth
  - Thermophilic
  - Mesophilic
  - Psychrotrotolerant

Thermoduric thermophiles

- Organisms that tolerate and actively grow at high temperatures
  - 45° to 122°C / 113° to 251.6°F
  - Optimum growth for most at 55°C/ 131°F
  - All Thermodurics may or may not be thermophilic
- Thermophiles of concern to the dairy industry
  - *Anoxybacillus flavithermus*
  - *Geobacillus stearothermophilus*
  - *Bacillus licheniformis*
  - *Bacillus coagulans*
  - *Bacillus subtilis*
  - *Bacillus sporothermodurans*

(Scott et al, 2007; Burgess et al, 2010; Tabit and Buys, 2010)

Thermoduric thermophiles grow rapidly

- Time it takes for a thermoduric thermophilic population to double in size or the exponential rate of increase is relatively very short
  - *Geobacillus* – 25 minutes
  - *Paenibacillus* – 45 minutes
  - *Anoxybacillus* – 30 minutes

Thermoduric mesophiles

- Thermoduric mesophiles in milk can also withstand industrial pasteurization temperature
  - Optimally grow in the temperature range of 20 - 37°C/ 68° - 98.6°F
- In addition to many aerobic and anaerobic spore formers, thermoduric mesophiles may also include some members of the genera *Lactobacillus* and *Streptococcus*

Thermoduric psychrotolerant

- Significant for the spoilage of refrigerated milk (7°C/ 44.6°F or below)
- < 10% of total bacteria counts (TBC) in raw milk
- In general thermodurics are not psychrotolerant. Some exceptions are as follows
  - *Paenibacillus* (*B. polymyxa*) was found in 66% of milk samples held at 5°C/ 41°F for 3 weeks
  - *Pseudomonas* is the other predominate psychrotolerant species isolated from milk, but it is not thermoduric
- High levels of thermoduric psychrotolerant bacteria shorten shelf-life and lowers quality of milk

(Ranieri and Huck, 2009; Wiedemann 2012)

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Role of thermoduric bacterial enzymes in spoilage

- Thermostable enzymes can be present even after bacteria have been killed
  - Shortens shelf-life
  - Decreases stability
  - Sourness
  - Rancidity
- Lipase; degrades fat
  - Acrid taste
- Protease; degrades proteins
  - Curdling
- Lecithinase; degrades lecithin
  - Sweet curdling

Credits

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