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Dairy Thermodurics

Module 1: Thermoduric Bacteria



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- Characteristics of common thermodurics

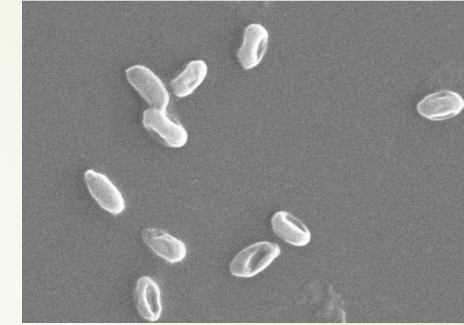


What are thermodurics?

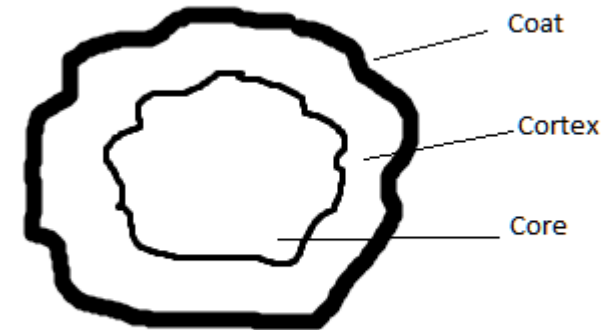
- ▶ Organisms that survive thermal processing treatments such as industrial pasteurization
- ▶ Some of these form spores, while other are non-sporulating
- ▶ The common sporulating genera considered thermoduric include
 - ▶ *Bacillus*
 - ▶ *Geobacillus*
 - ▶ *Clostridium*
- ▶ More recently
 - ▶ *Paenibacillus*
 - ▶ *Anoxybacillus*

What are spores?

- ▶ Spores are bacterial adaptation to adverse conditions
 - ▶ They are dormant forms of bacterial cells
 - ▶ Thick outer covering consists of highly cross-linked polypeptides and peptidoglycan
 - ▶ Spore core (cytoplasm)- consists of necessary metabolic components and DNA
 - ▶ Allows resistance to extreme temperature such as pasteurization, cleaning and sanitation procedures



SEM *Bacillus* species
Som and Anand, 2012



Carlin, 2010; Atrith, 2002; Mansur et al, 1998

Thermotolerant bacteria that do not sporulate

- *Lactobacillus*
- *Streptococcus*
- *Enterococcus*
- *Alcaligenes*
- *Micrococcus*
- *Microbacterium*
- *Coryneforms*
- *Arthrobacter*

Characteristics of common thermodurics



Bacillus sporothermodurans

- ▶ First detected as a high heat-resistant spore (HHRS) in UHT milk
 - ▶ D_{140} and Z values of spores of 3.4–7.9 s and 13.1–4.2°C, respectively
- ▶ Strictly aerobic, can hydrolyze casein
- ▶ Contributes to the reduced quality of commercially sterilized milk and milk products
 - ▶ Due survival and out growth of the spores to unacceptably high levels
- ▶ Non pathogenic

*(Pettersson et al, 1996; Humer et al, 1998;
Vaerewijck et al, 2001; Tabit and Buys, 2010)*

Bacillus coagulans

- ▶ A lactic acid forming species within genus *Bacillus*
 - ▶ Initially considered a spore-forming *Lactobacillus*
- ▶ Facultative anaerobic sporeformer
 - ▶ Some strains do not sporulate readily
 - ▶ Optimum growth temperature 40 and 57°C
 - ▶ Growth range 15°C-61°C
- ▶ Involved in coagulation and flat souring of evaporated canned milk

(Nakamura et al, 1998; Vecchi and Drago, 2006;
Burgess et al, 2010; Vercammen et al, 2011)

Geobacillus (*Bacillus*) *stearothermophilus*

- ▶ Aerobic or facultative anaerobic endospore-forming rods
- ▶ Optimum growth temperatures is 50 °C
 - ▶ Grows between 37°C to as high as 76°C
 - ▶ Spores of are extremely heat resistance with D_{121} value of 42s
- ▶ Typically responsible for the flat-sour spoilage of low-acid canned foods, including evaporated milk

*(Head et al, 2008; Nazina et al, 2001; Dogan et al, 2009;
Burgess at al, 2009; Viedma et al, 2010)*

Anoxybacillus flavithermus

- ▶ Obligate anaerobic or facultative aerobic
 - ▶ Optimum growth temperature is 60 and 65°C under aerobic and anaerobic conditions, respectively
 - ▶ Spores are very highly heat resistant
- ▶ Recognized as a major contaminant in milk powder
 - ▶ Normally present at low levels in raw milk
 - ▶ May reach up to 10^5 cfu/g levels in the final product after 15–20h of plant operation
 - ▶ Being thermophilic, rapidly form biofilms

(Ruckert et al, 2004; Heinin et al, 1982; Pikuta et al, 2000, Burgess et al, 2010; Palmer et al, 2010)

Bacillus licheniformis

- ▶ Facultative anaerobe of *Bacillus subtilis* group
 - ▶ Other members *B. subtilis*, and *B. pumilus*
- ▶ Optimum growth temperature 30°C
 - ▶ Can grow from 15 to 55°C
- ▶ Considered a common spoilage organism isolated from raw milk
 - ▶ Some strains have been associated with toxin production

(Mansour et al, 1999; Salkinoja-Salonen et al, 1999;
Burgess et al, 2010)

Paenibacillus species

- ▶ Recognized as a new genus *Paenibacillus* in 1993
 - ▶ Since then, over 26 species have been identified within the genus *Paenibacillus*
- ▶ Facultative anaerobic or strictly aerobic
- ▶ Can grow from 10 to 40°C, the optimum being 37°C
- ▶ Recognized as an important fluid milk spoilage organism
 - ▶ Found in both raw and pasteurized milk

(Daane et al, 2002; Huck et al, 2007)

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