

Effect of milk storage duration and temperature on the microbial and manufacturing quality of mid lactation bulk tank milk

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Introduction

- **Previous studies on milk storage have been undertaken on a given supply of milk stored under refrigeration conditions**
- **The purpose of this study was to look at the effect of storage conditions on farm (in vivo)**
 - **blending milk affects milk quality**

Overall it is anticipated that this study will provide appropriate storage guidelines for farmers and processors alike

Storage Temperature

- **EU food hygiene legislation- Directive 853/2004**
 - “Immediately after milking, milk must be cooled to not more than 8°C in the case of daily collection, or not more than 6°C if collection is not daily”
 - Cooling to this level, rather than 4°C, should have considerable energy savings for dairy farmers but may have significant impact on milk quality with longer storage times
 - Cooling to lower temperatures may be critical if storing for 3/4 days
- **Observations of storage conditions from milk quality award nominees indicate that storing to lower than the normally recommended level of 4°C is practiced – average was 2.7°C**

Storage duration

- **A decline in milk quality may occur after a storage period of 3 days**
- **Milk with an initial TBC of 5,000 and stored at 4° C would be expected to have a TBC of 10,000 or 30,000 after 2 or 3 days storage & 100,000 at 4 days**
- **Initial milk TBC important- final TBC dependant on the initial TBC**
- **Improvements in the standard of cooling equipment can also impact on extending the storing period without affecting milk quality**
 - **More efficient plate coolers**
 - **Better insulated milk tanks**

Objective:

- **To establish the effect of milk storage duration (5 days) and storage temperature (2, 4 & 6 °C) on the microbial and manufacturing quality of bulk tank milk in mid lactation**
- ***Microbial analysis data - will be presented***

Materials and Methods

- **3 identical bulk milk tanks**
- **Milk supply at milking diverted three ways**
- **Fresh milk added at each milking – 8 occasions per week**
- **Milk sampled once daily and collected by the processor on day 5**
- **Each temperature treatment was analysed 6 times, twice in each tank (6 week trial)**
- **Mid lactation, Cows at pasture & full teat preparation including pre-milking teat disinfection**
- **Analyses for microbiological & processing quality of milk**
- **All energy usage and ambient temperatures recorded**

Sampling procedures

• In-line drip sample taken to assess the quality of milk entering the tank at each milking

- TBC & Thermoduric count
- Milk composition
- SCC



Each tank sampled at 24h intervals and milk tested for microbiological & processing quality of milk



Three identical milk tanks



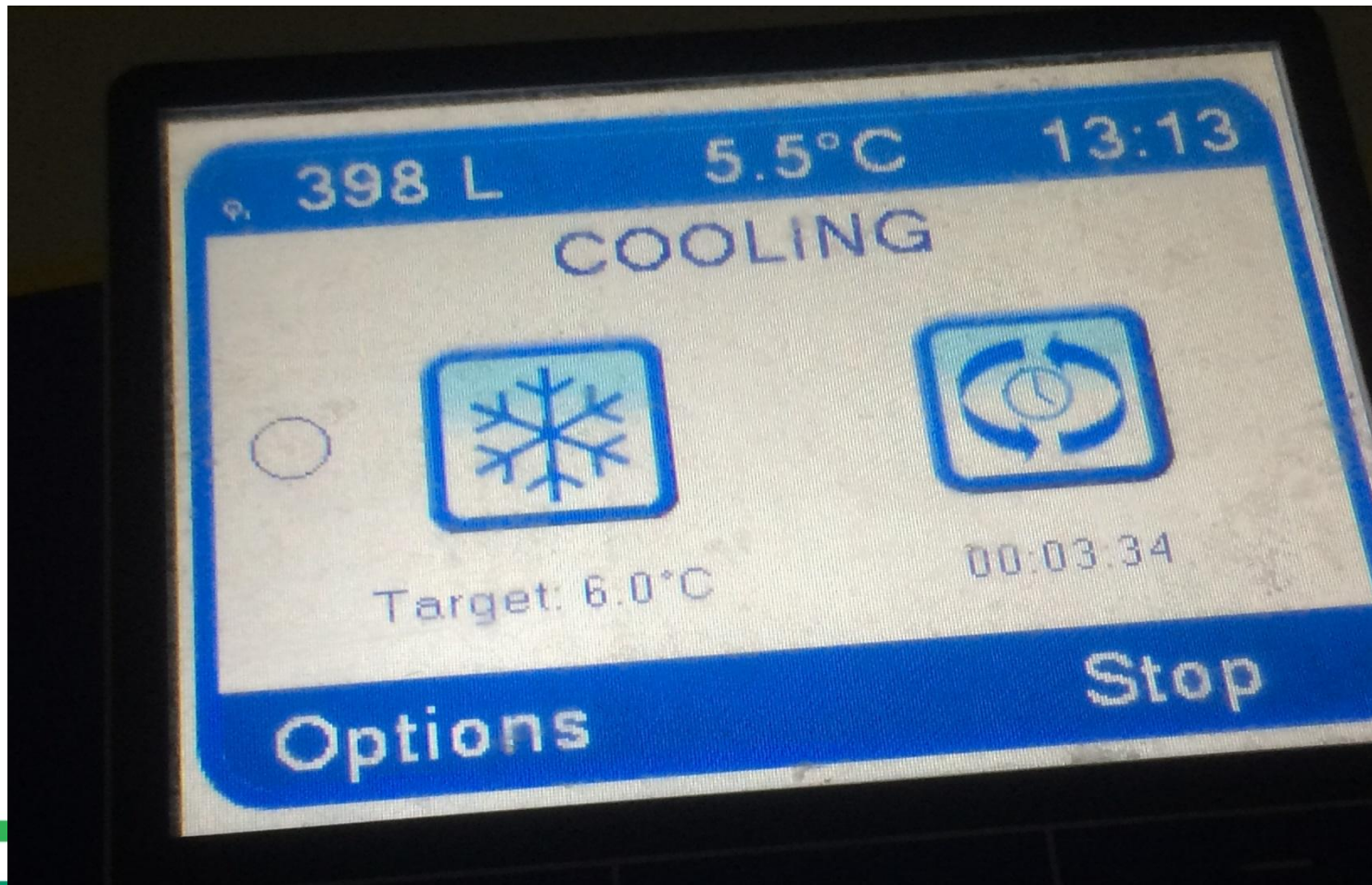
Bulk Tank Specification

- **3 x Dairymaster SwiftCool Milk tanks – 4000litre**
 - **20% Thicker insulation and thicker steel!**
 - **Soft start mode if low milk level in tank**
 - **Milk volume display**
 - **Alert messages to mobile**
- **Condensing unit -5.5hp**
- **3 x Single stage coolers- 37 plates- milk cooled to 14.5°C - before entering tank**

One plate cooler for each milk tank



Bulk milk tank display screen



Microbiological and Manufacturing tests

•Microbiological tests:

- Total bacterial counts
- Thermoduric counts
- Psychrotrophic bacteria
- Psychrotrophic - thermodurics
- Proteolytic count
- Lipolytic count
- Sulphite Reducing clostridia
- *Bacillus cereus*
- Somatic cell count

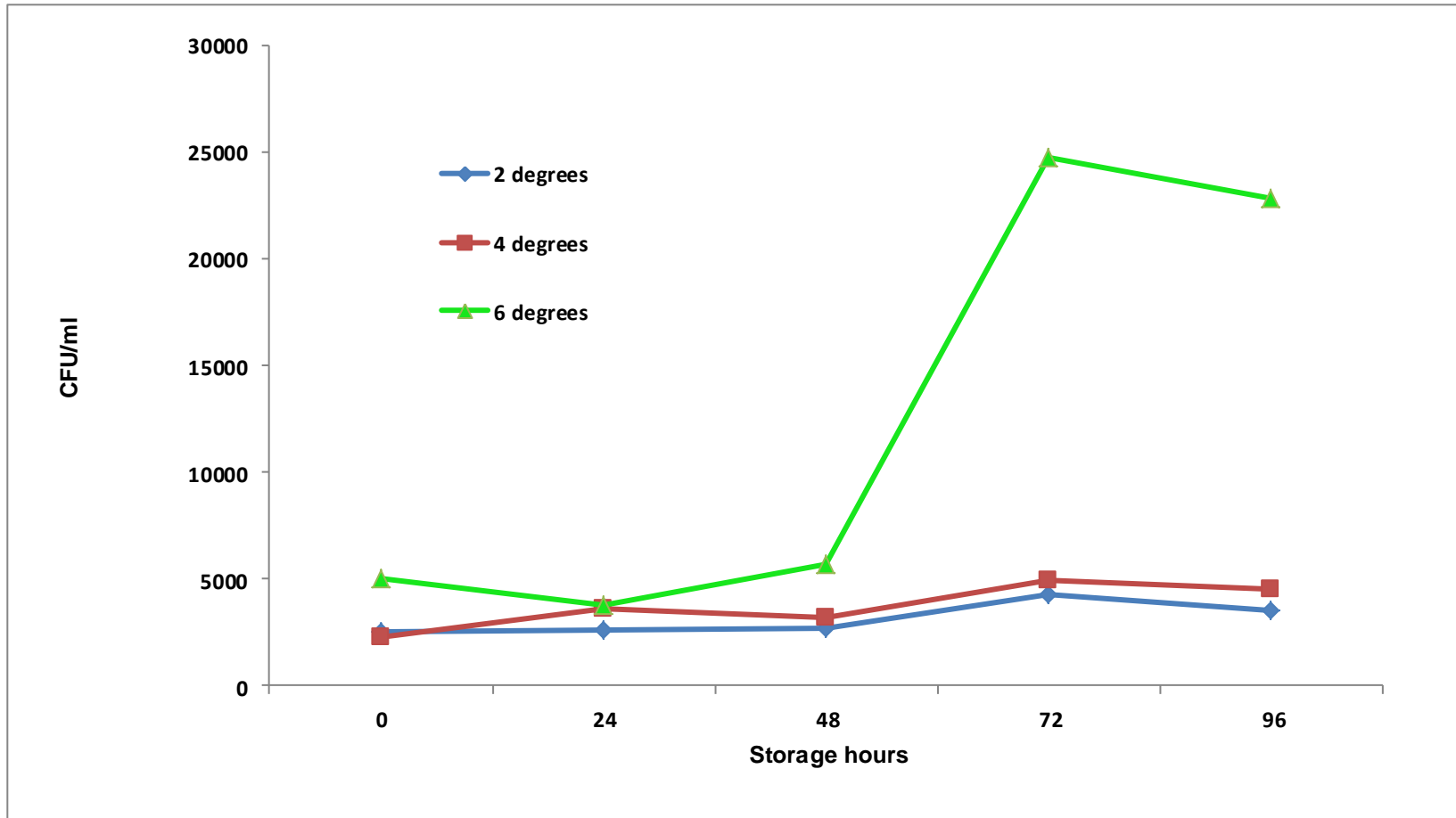
•Manufacturing tests:

- Rennet Coagulation
- Protein profile
- Calcium
- pH
- Amino Acid
- Volatile compounds
- Nitrogen
- Plasmin and peptide
- Heat stability
- Titratable acidity

Materials and Methods

Test	Milk	Media	Incubation
TBC	Raw	Petrifilm	37°C for 48 hours
Psychrotrophic count	Raw	Petrifilm	7°C for 10 days
Thermoduric count	Pasteurised during test	Petrifilm	37°C for 48 hours
Thermoduric psychrotrophic count	Pasteurised during test	Petrifilm	7°C for 10 days
Lipolytic count	Raw	Tributyryn agar with added Glyceryl tributyrates	37°C for 48 hours
Proteolytic count	Raw	Calcium caseinate agar with added skim milk powder	37°C for 48 hours
Presumptive <i>Bacillus cereus</i>	Raw/Pasteurised during test	Bacara agar	32°C for 48 hours
Sulphite-reducing <i>Clostridia</i> spp.	Raw	Sulphite iron agar	37°C for 72 hours

Effect of storage temperature and time on TBC



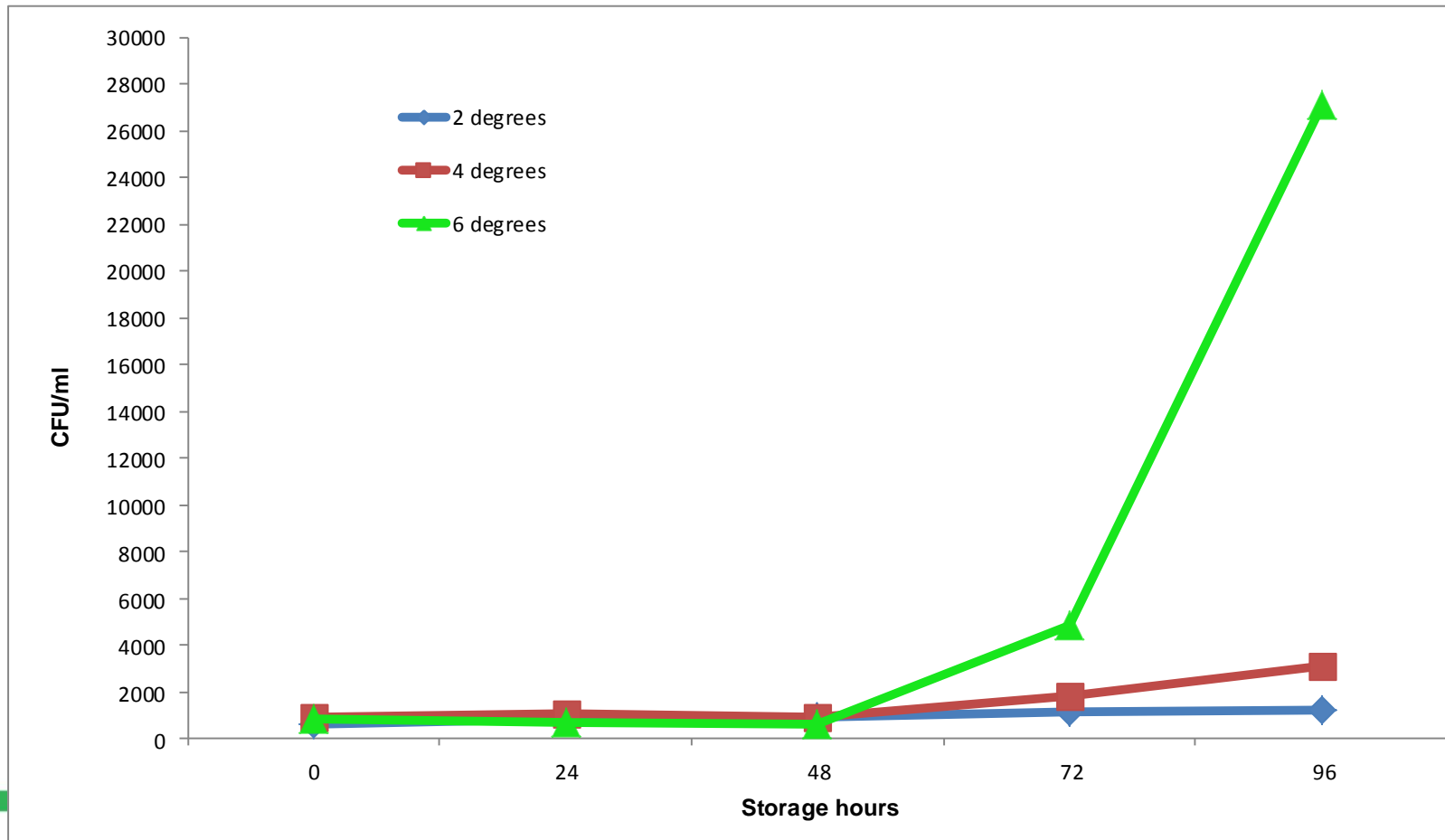
TBC range with 3 storage temperatures

Storage Temperature	2	4	6
% of samples > 5,000	7	31	55
% of samples > 10,000	3	7	41

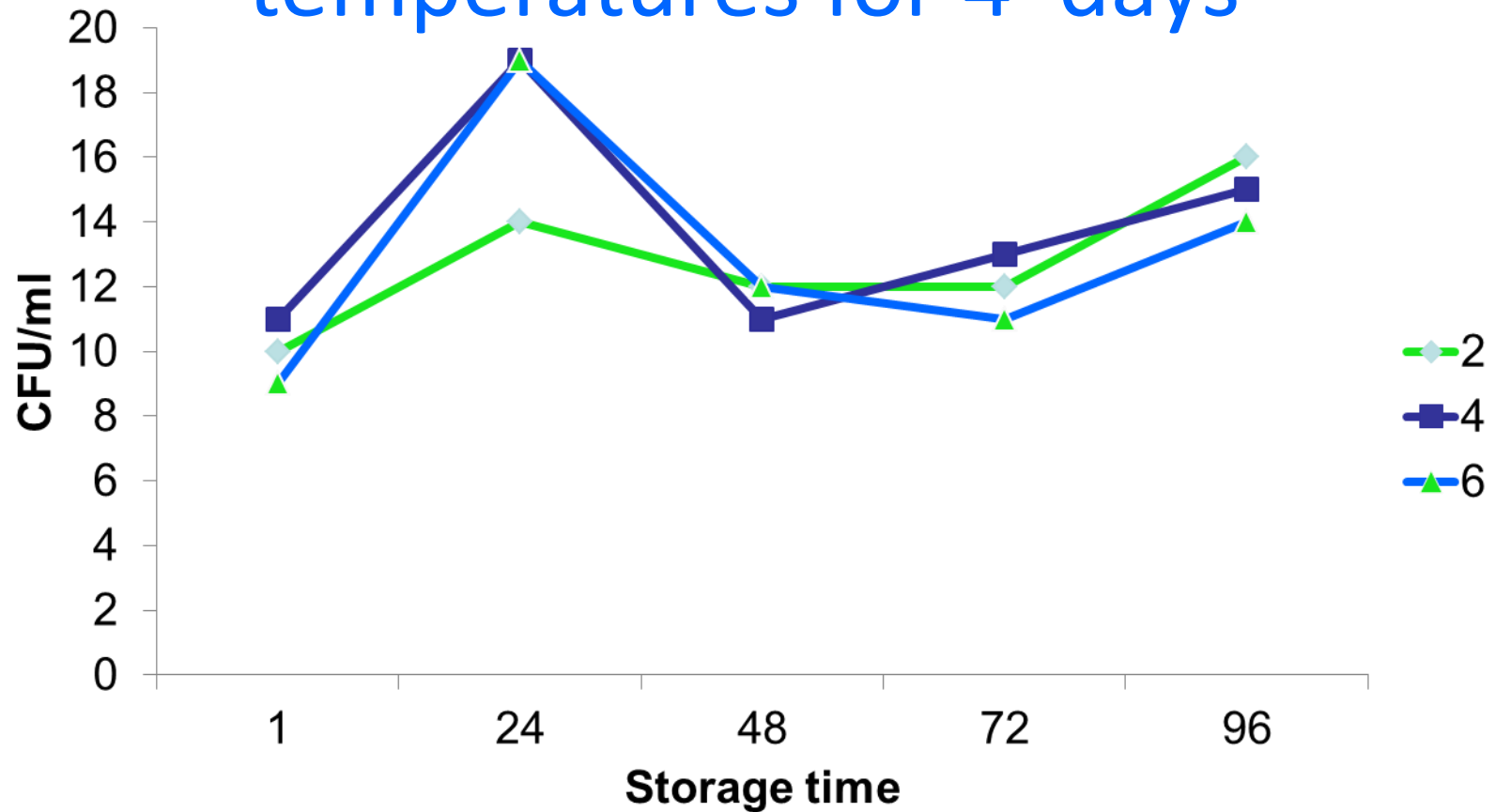
Psychrotrophic bacteria

- Low temperatures allow the growth of psychrotrophic bacteria
- Psychrotrophic bacteria can cause spoilage of final product during storage
- Psychrotrophic bacteria in raw milk include gram-negative pseudomonas & gram-positive *Bacillus and Streptococcus*
- EU standard - 5,000 CFU/ml

Effect of storage temperature & time on psychrotrophic bacteria

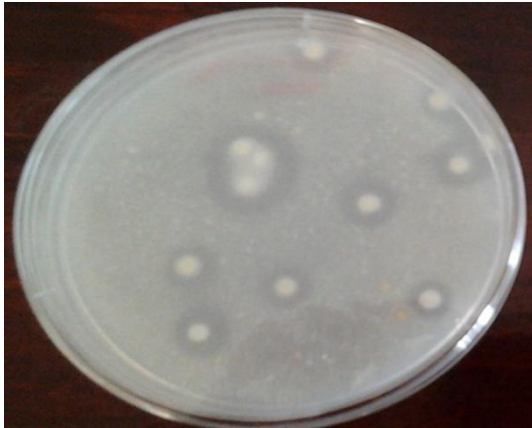


Thermotolerant count of milk stored at 3 temperatures for 4 days

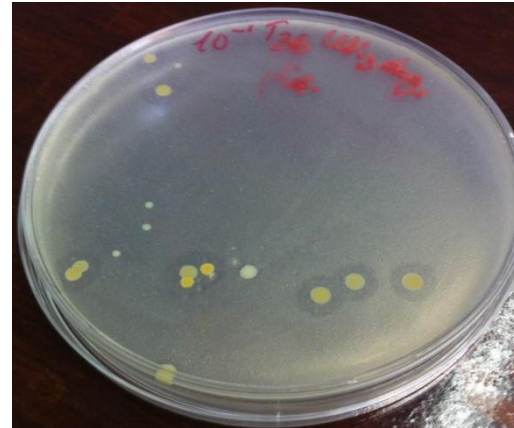


Proteolytic and Lipolytic bacteria

-Proteolytic bacteria



-Lipolytic bacteria



- Proteolytic and lipolytic bacteria are mostly psychotrophic in raw milk
- Regarded as a frequent cause of unexplained problems in milk processing
- Proteolytic bacteria can survive pasteurization and cause defects in UHT milk
- With cold storage counts increase
- Lowest levels observed where cows are grazing outdoors and teats are pre-dipped with disinfectant

Proteolytic bacteria (cfu/ml)

	Storage temperature		
Storage time (hrs)	2	4	6
1	745	725	779
24	712	658	759
48	738	748	858
72	498	401	717
96	443	335	677

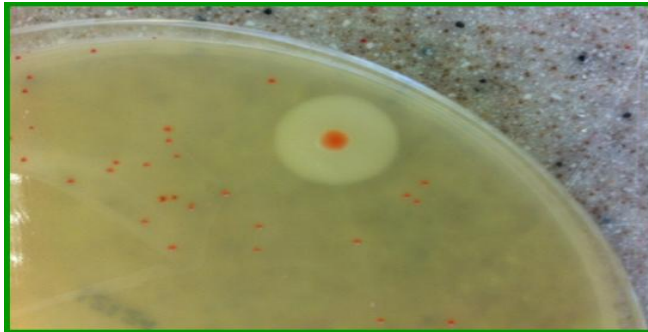
Lipolytic count (cfu/ml)

	Storage temperature		
Storage time (hrs)	2	4	6
1	925	761	895
24	579	919	1005
48	832	963	688
72	853	803	1047
96	619	673	860

Presumptive *Bacillus cereus* and Sulphite-reducing *Clostridia* spp.

Presumptive *Bacillus cereus*

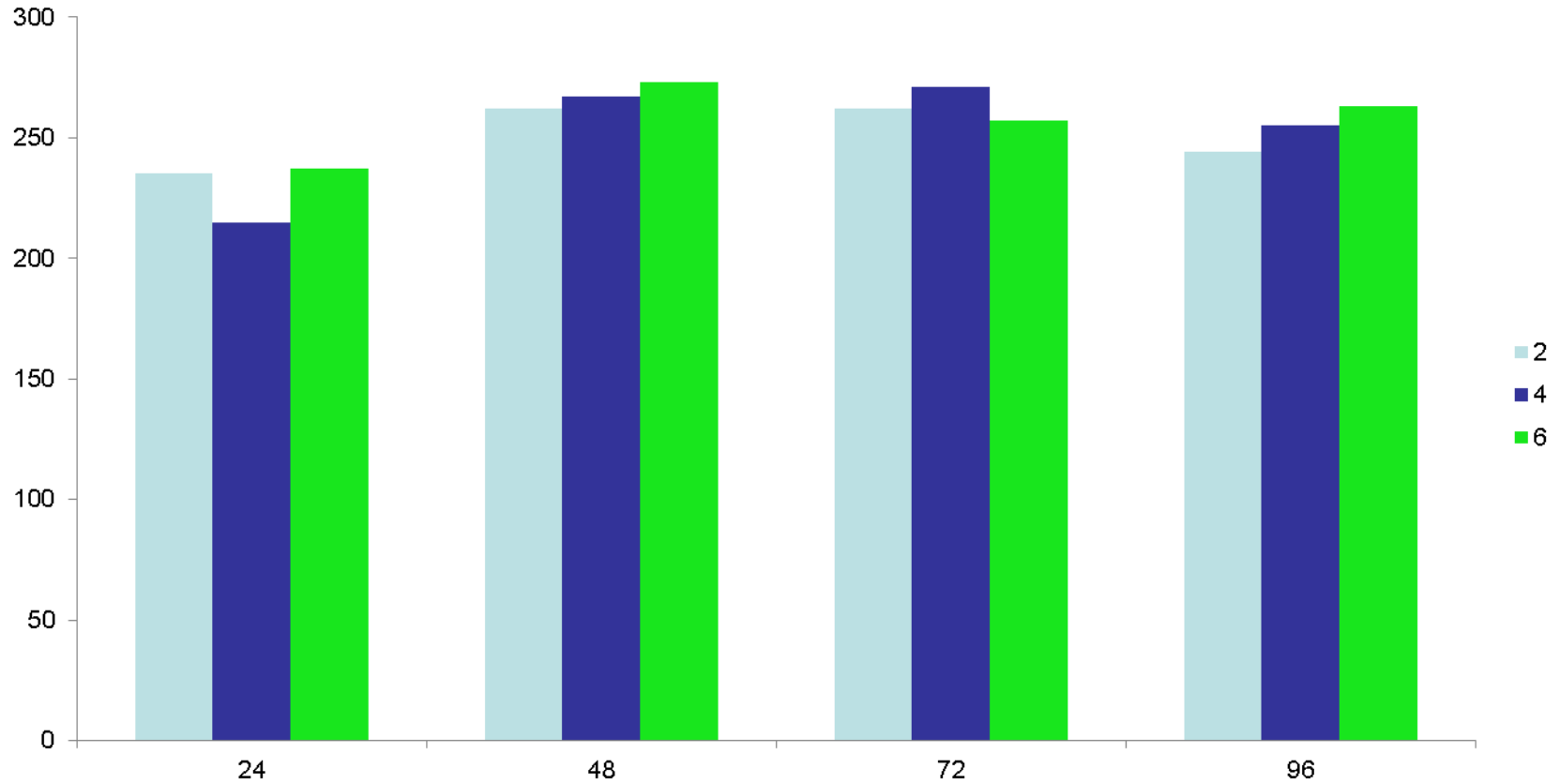
- 7% of all milk samples were positive for *Bacillus cereus*.
- Evenly distributed across all temperature & time



Sulphite-reducing *Clostridia* spp.

- 3% of all samples were presumptive SRC/SRB.
- Evenly distributed across all temperatures & time
- Much higher levels observed for late lactation milk- 18%

Somatic cell count (cells/ml)



Summary-Microbiological tests

- **TBC**
 - Initial milk quality excellent --3,000 CFU/ml
 - Low TBC levels maintained in milk stored for 4 days when cooled at 2 or 4°C – no advantage to storing at 2°C
 - Large variation in milk TBC and higher levels from 3 days when stored at 6°C
- **Psychrotrophic counts**
 - Large variation and higher psychrotrophic counts from 3 days at 6°C
- **Thermoduric**
 - No change in low thermoduric counts with storage temperature
- **Proteolytic and lipolytic**
 - No difference with storage time or temperature
- **SCC**
 - No difference with storage time or temperature

Warning

- **Not all dairy farmers will achieve these results - initial TBC important**
- **Influence of tank design, compressor size and plate cooler efficiency- IMPORTANT**
- **Rate of cooling may be critical**

Future studies on cooling

- **Late lactation milk – higher initial TBC!**
- **Energy consumption at different cooling temperatures**
- **Benefits of quick cooling- ice/plate cooling**
- **Plate cooler water usage/costs/savings**
- **Option of maximising the use of night rate energy 2°C at night and 6°C by day-quality**
- **Prolonged storage – including storage at the processing facility**

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•Thank You