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 4^0C is practiced – average was 2.7^0C

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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 ^{0}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^{0}C - before entering tank**

One plate cooler for each milk tank

Bulk milk tank display screen
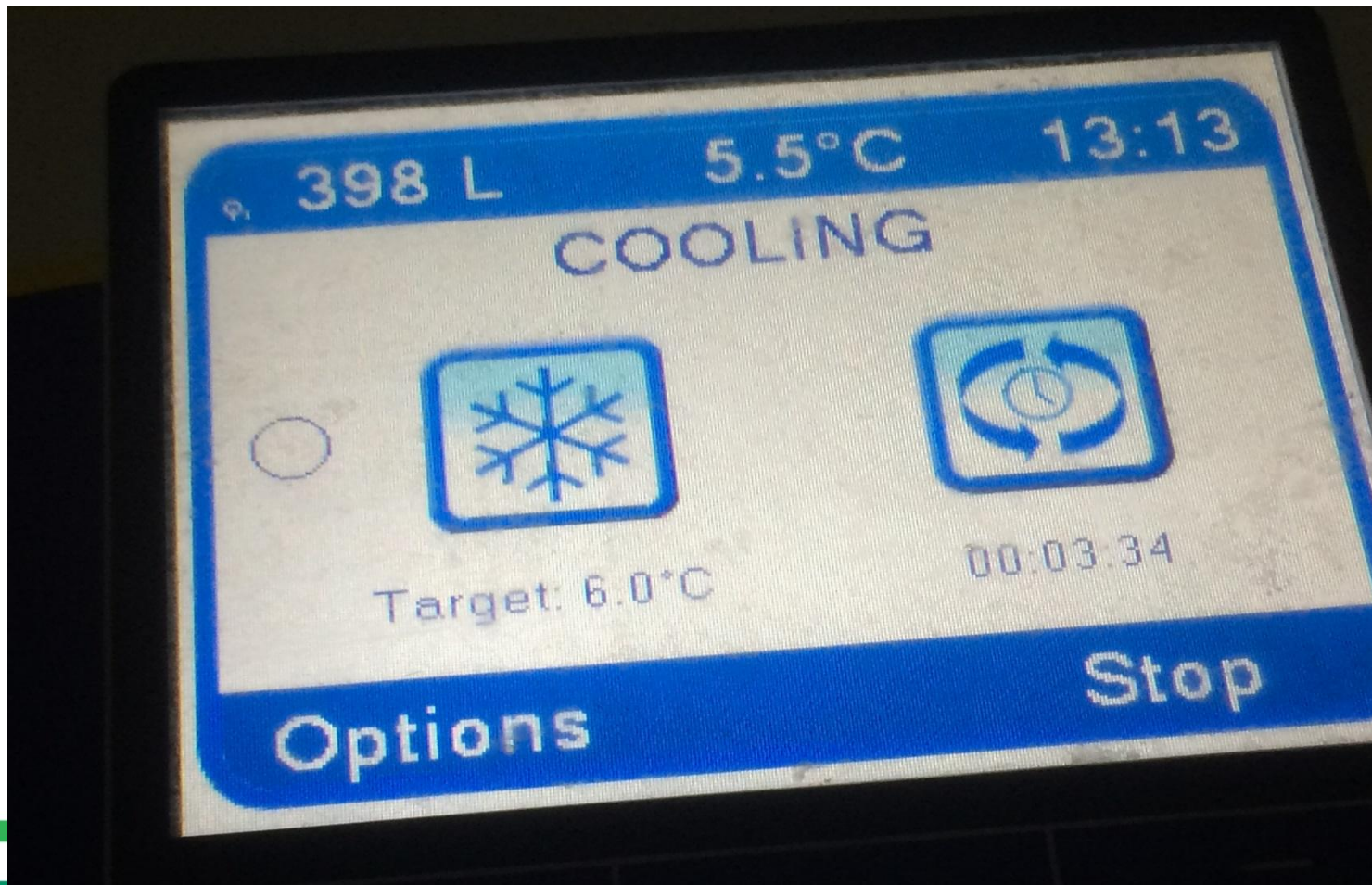
Microbiological and Manufacturing tests

•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	Tributyrin agar with added Glyceryl tributyrate	37°C for 48 hours
Proteolytic count	Raw	Calcium caseinate agar with added skim milk powder	37°C for 48 hours
Presumptive *Bacillus cereus*	Raw/Pasteurisedduring test	Bacara agar	32°C for 48 hours
Sulphite-reducing *Clostridia* spp.	Raw	Sulphite iron agar	37°C for 72 hours

# Effect of storage temperature and time on TBC
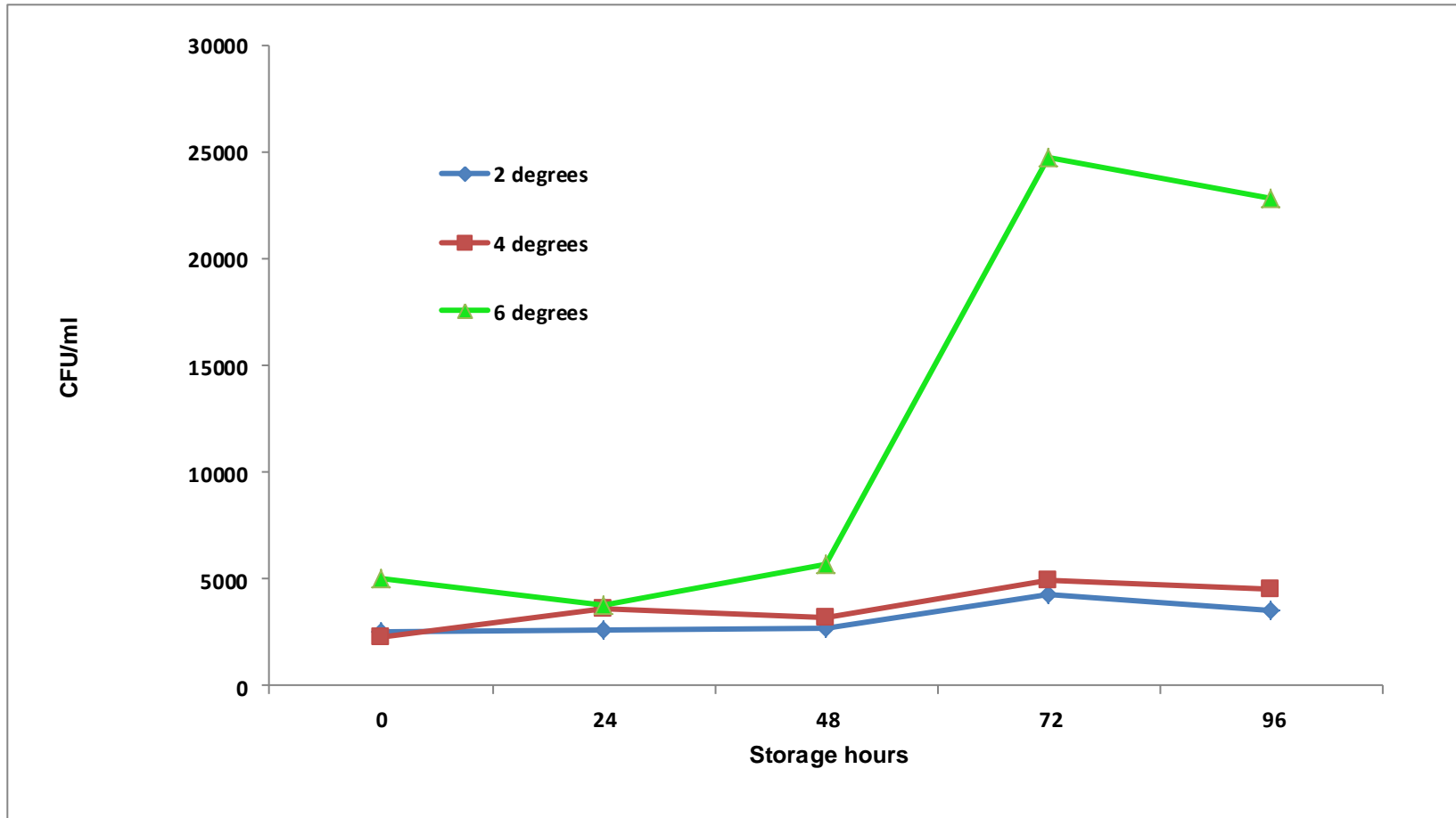
TBC range with 3 storage temperatures

| 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
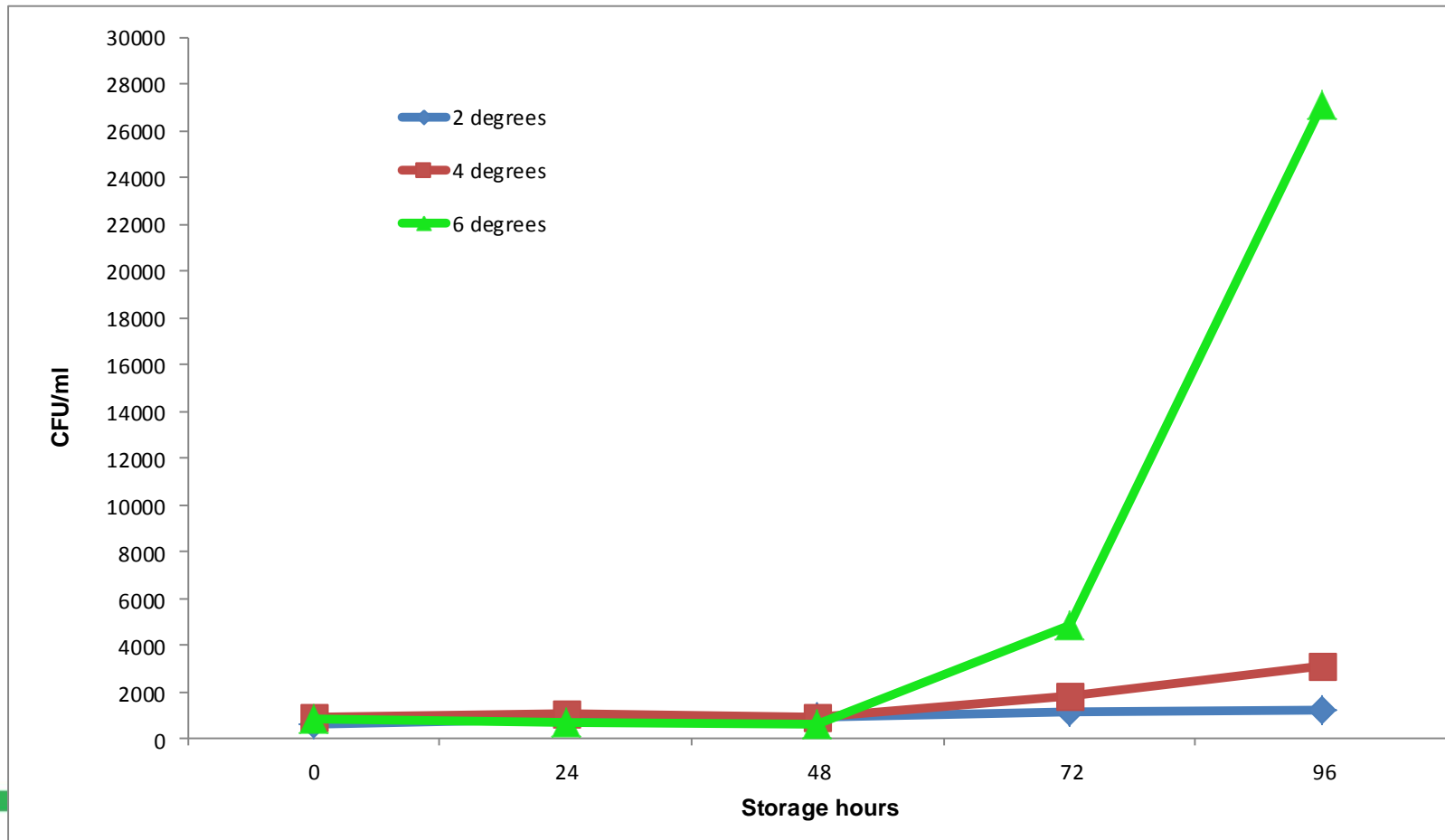
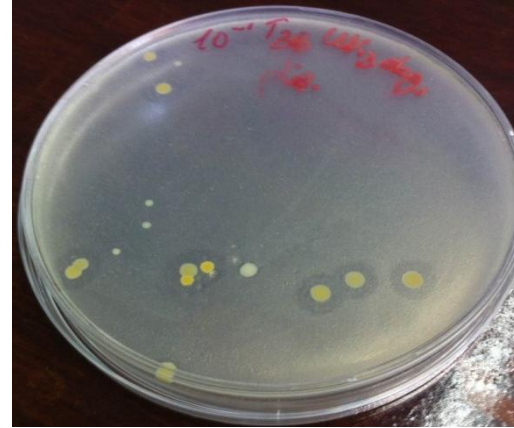# Thermoduric count of milk stored at 3 temperatures for 4 days
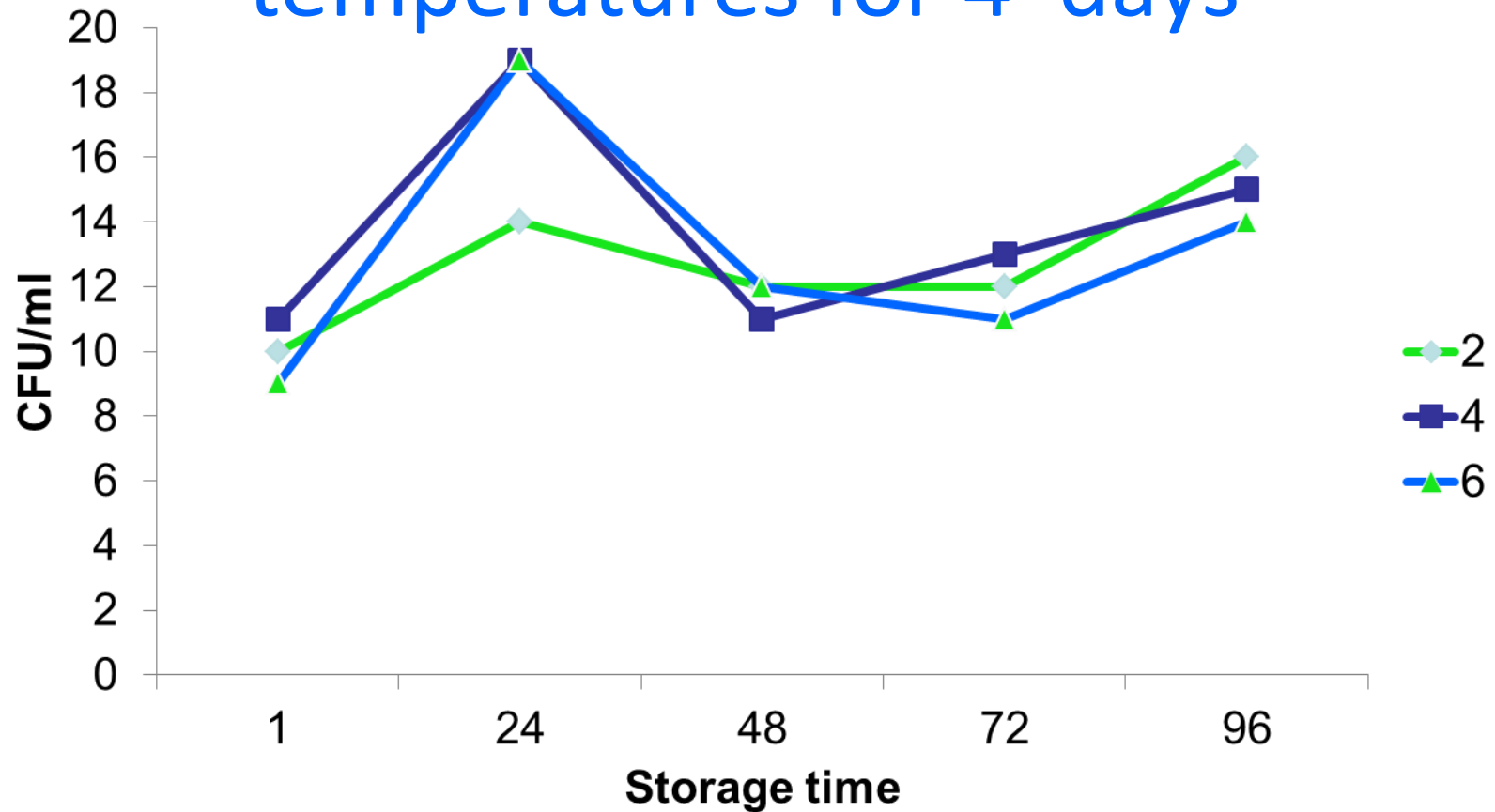
Proteolytic and Lipolytic bacteria

-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 time (hrs)	Storage temperature		
	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 time (hrs)	Storage temperature		
	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.

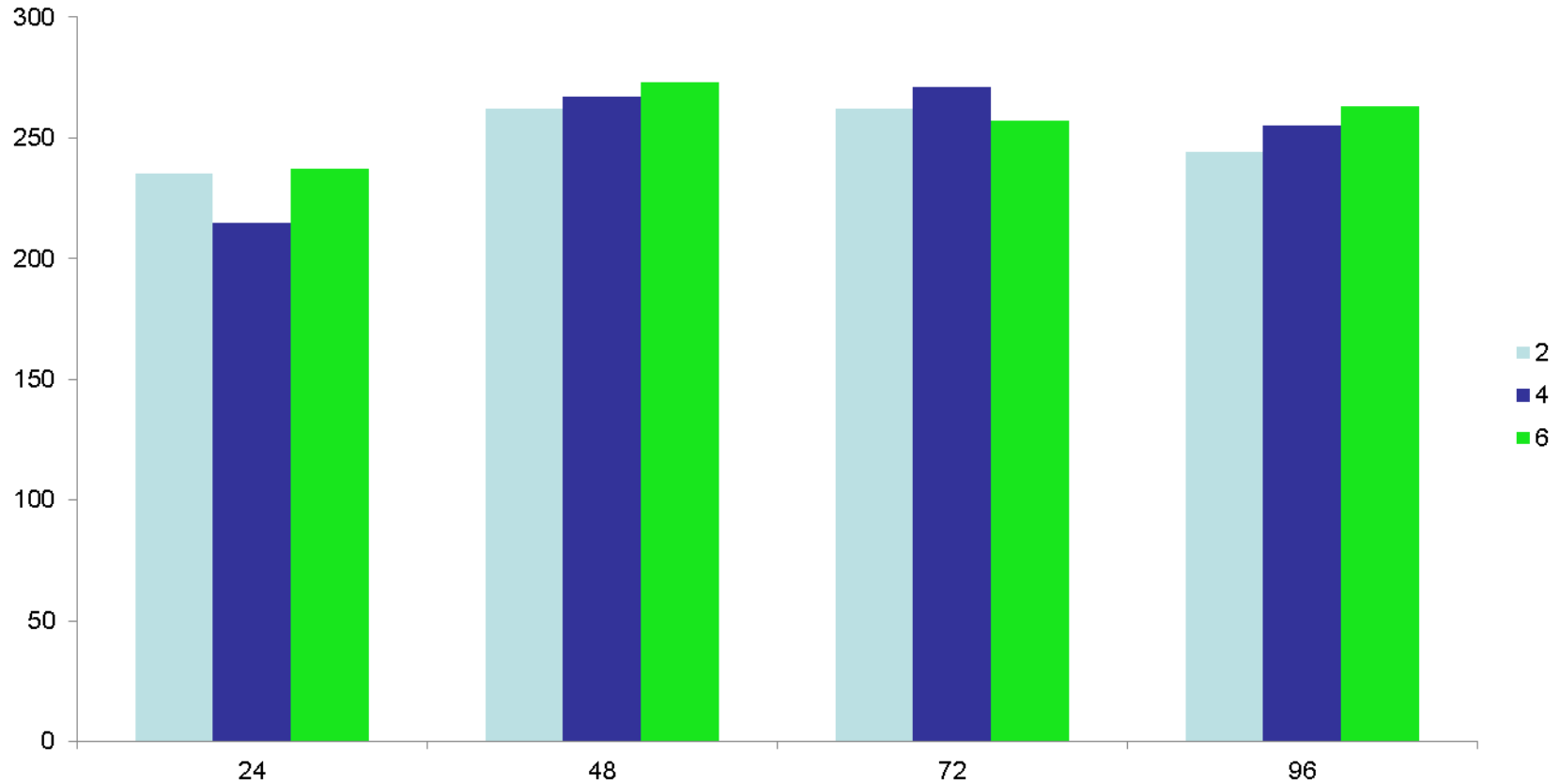**Presumptive *Bacillus cereus***

- 7% of all milk samples were positive for *Bacillus cereus.*

- Evenly distributed across all temperature & time
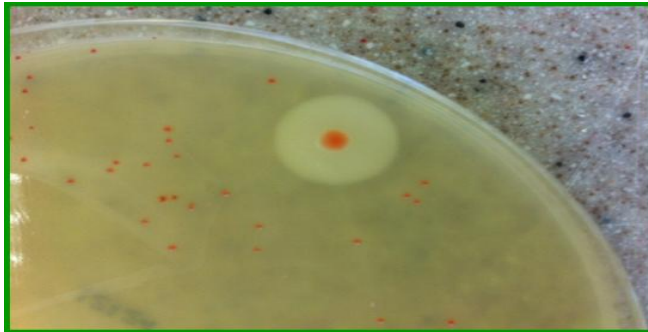
Sulphite-reducing *Clostridia* spp.

- 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**

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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