Milking machine wash routines

Dr David Gleeson
IMQCS ,
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Milk quality parameters

- Milk quality issues that are important to the processor and that impact on milk price

  - Total bacterial counts
  - Thermoduric bacteria
  - Somatic cell counts
  - Residues-TCM, Chlorates, Iodine

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Milk quality parameters

Parameter	Threshold		Source
	Desired	EU Regulations	
Total bacteria count TBC	<30k	≤100k	Improper cooling Poor teat preparation Poorly cleaned machine Prolonged storage
Thermoduric count LPC -Bacillus Cereus	N/D Penalty > 500 cfu/mL	≤ 1k	Soil Cows teats Poorly cleaned machine Cracked old rubberware
Somatic cell count SCC	<200k	≤ 400k	Poor teat preparation and disinfection, Milking infected cows among healthy cows Malfunctioning machine Mastitis

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Why are thermoduric bacteria a problem

- Contamination of milk with thermoduric bacteria can cause processing problems for the dairy industry-reduced prices for product – cheese
  - **Bacillus Cereus important spore - infant milk formula**
- Spores exist in form capable of surviving pasteurisation- can resist high temperature
- Thermoduric bacteria (Psychrotrophs) can multiply in milk on the supermarket shelf, which may reduce the shelf life of milk

- ***Penalties are imposed by processors in Ireland on Thermoduric counts >500 cfu/ml***

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Sources of Thermoduric Bacteria

(thermoduric bacteria live in the environment)

- Soil (30-150 spores/100ml)

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- Silage (.05-50 spores/100ml)
- Faeces (2-100 spores/100ml),

↓

- bedding,

↓

- Teat Skin
- parlour hygiene

- With inadequate milking equipment cleaning deposits build up on contact surfaces

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Sources of Thermoduric bacteria -Weather effect

- **High water content of soil, dirty passageways**
- **Increased soil consumption occurs during wet weather due to increased levels of soil present on grazed grass -faeces**
- **Higher spore levels can also occur during periods of dry weather**
  - **Drought conditions, tight grazing-soil on teats**
  - **Vital have clean roadways and approach roads to the parlour -Clean collecting yards after each milking occasion**
    - **Cleaning teats critical**

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Summary

- *Teat skin contains infinite numbers of bacteria*

- *Reducing the numbers of bacteria on teats by good management practises, washing/drying, pre-spraying with disinfectant + DRYING will minimize the amount of bacteria entering the bulk milk tank*

- *Automatic disinfection of clusters between individual milking's (clustercleanse/MPK) will minimize the possibilities of cross-infection and the amount of bacteria entering the bulk milk tank*

Milking equipment & Thermoduric bacteria

- ***Thermoduric bacteria will grow on Biofilms (milk-stone, mineral deposits from water, fat deposits)***
- ***Weekly Acid descale wash vital, more frequent required if hard water***
- ***Peractetic acid wash in additional rinse- very effective especially if there is a water quality issue***
- ***Replace old rubberware***

Rubber as a source of bacteria

- ***Cracked rubberware allows bacteria to survive, protected from hot water and chemicals***

- ***Exposure of rubber to chlorine for long periods will cause rubber to deteriorate more quickly---hence the importance of using cleaning products the correct way***

➢ ***Shock treatment will destroy rubber***

Soils that might occur in milking machines include:

- **Organic residues (from milk)**

  - Lipids (fats), proteins, carbohydrates (sugars)-removed with **detergent (caustic)**

- **Mineral deposits (mainly from water)**

  - Calcium, magnesium, iron, others-removed with **acid**

- **Bacterial films**

  - Bacteria can form bio-films on organic substrates if allowed to incubate

- **Chemical residues**

  - Cleaning solutions, iodine, teat sealants

Product types used for cleaning and disinfection of milking equipment

- **Detergent-powder or liquid-NO PCS**
  - Contains Sodium hydroxide (caustic soda) +surfactants/wetting agents
- **Detergent/sterilizer -REQUIRES PCS**
  - Contains sodium hydroxide + sodium hypochlorite (chlorine) + surfactants/wetting agents
- **Acid descaler**
  - Contains Phosphoric acid +
- **Peracetic acid**
  - Contains Acetic + hydrogen peroxide- **REQUIRES PCS**
- **Sodium hypochlorite-** Contains chlorine only-**REQUIRES PCS**

Teagasc Detergent lists

- Detergent/steriliser products should be registered with DAFM– biocide regulation
- Some products are not registered, therefore not legal to use on farms

- Moorepark website

  http://www.agresearch.teagasc.ie/moorepark/milkquality

- **Separate table for**
  - » **Detergent/sterilizer**
  - » **liquid caustic only products**
  - » **Powder products**
  - » **Sodium hypochlorite**

- **Registered products only are listed-PCS**

Detergent list also used in UK by dairy farmers

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https://www.teagasc.ie/media/website/animals/dairy/joint-programmes/Chemicalanalysisofdetergentsterilizerproducts_201704.pdf

Table 1. Caustic and chlorine contents for registered detergent-sterilizer products on the Irish market (Teagasc, April, 2017. Product names in order of decreasing caustic content.

Product Name	PCS number	% Caustic	*Working solution (ppm)		% Chlorine	*Working solution (ppm)	
			Hot wash	Cold wash		Hot wash	Cold wash
These products are best used in a daily hot wash with option of re -using solution as a cold wash at the next milking.							
Top Circulation Cleaner	97354	21.46	1073	2146	3.41	171	341
Megasant	96852	20.91	1394	1626	3.63	240	280
Turbosan Co-op Source	96861	20.84	1042	2084	2.85	143	285
LIR Agri Pipeline Steriliser	97824	20.50	1640	1948	2.83	226	269
Kilcosan	97355	20.00	1000	2000	3.4	170	340
Cryosan liquid	96895	18.67	1245	1867	3.45	230	345
Dairygold Hotwash XT	96461	18.34	1467	1651	2.61	209	235
Deosan Diamond	97351	18.02	901	901	2.61	131	131
Cipsan Liquid	97775	17.86	1191	1588	3.05	203	271
Hydrosan Liquid	93608	17.69	1179	1769	3.05	203	305
Puresan line cleaner	96216	17.48	1165	1748	2.31	154	231
Unisan Liquid	96944	17.30	1151	1534	2.67	178	237
Parlorsan	96404	17.14	1371	1600	3.68	294	343
Aquasan	97375	16.80	1344	1493	3.26	261	290
Avalksan	96840	16.54	1286	1470	3.49	271	310

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Chemical analyses of detergents

- **Liquid Caustic range:**
  - **Range --- 1 to 39 %**

- **Chlorine range:**
  - **<1 to 9.5%**
  - **Max of 3.5% recommended**

- **Powder products have a high concentration of sodium hydroxide/carbonate -76%- less risk of residues**

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Important points in relation to detergent sterilizers

- A minimum of 950 ppm in the working solution is suggested for detergent sterilisers where the product is used hot AM and recycled cold PM

  (e.g. 12.5% caustic @ 340mls/45 litres = 944 w.s. approx)

- Detergent/sterilisers with a lower working solution (>300ppm) may give satisfactory cleaning when used with hot water daily and not recycled

- If not recycling a detergent/steriliser product & using product with high caustic content (>14%) & hot water- then half the recommended rates may be sufficient

- Increasing the usage rate of products to achieve higher caustic levels may result in non-acceptable levels of chlorine in the working solution.

- Acceptable chlorine levels in the working solution may range between 150 and 320 ppm depending on the temp of water (e.g. 3.5% chlorine@ 340mls/45litres =264 w.s. approx

Correct use of products

- *Detergent-sterilizer products (containing chlorine) should be rinsed from the milking system with clean water immediately after the main wash cycle is complete (8/10 min) to prevent the chlorine from damaging the rubberware*

- *Detergent-sterilizer products or detergent powder products may be re-used on one occasion -where recommended by the manufacturer*

- *When using detergent-only products (powder or liquid caustic with no chlorine), for effective cleaning the stain of the solution should be left in the plant or bulk tank and then rinsed just prior to the next milking*

Milk-stone removal

- ***Descale (acid) wash should be carried out weekly to both machine and bulk milk tank to remove mineral deposits from water***

- ***High 'water hardness' levels will effect the cleaning ability of detergents and allow the build up of Bio-films on stainless steel surfaces which will accommodate the growth of thermoduric bacteria***

- ***Under no circumstances should acid (milkstone remover or peractic acid) come into contact with detergent – rinsing required between* each product**

Peracetic acid

- ***Peracetic acid may be used to sterilize a milking plant pre-milking or for the disinfection of clusters between individual cows (as a replacement for chlorine)***

- ***The use of peracetic acid in the final rinse water is beneficial where the microbial quality of the water supply may be considered an issue***

- ***When used at the rates recommended, further rinsing with water to remove stains is not considered necessary***

- ***Under no circumstances should peracetic acid come into contact with detergent – rinsing required between*** **each product**

Problems with use of detergent products

- Some products with limited recommendations on usage rate
- Expiry date- 6 months from manufacture –group buying
- Extra chlorine added at farm level to main wash to compensate for poor product
- New products used on farm, usage rates different, recalibration required
- Confusion with regard to correct washing procedure
- Swing towards non-chlorine wash routines to minimize residues

Calculating the quantity of detergent required per day

- **Example**
- **Usage rate = 375 mls per 45 litres of water**
- **9 litres water per unit (recommended) x 20 units =180 litres p/wash**
- **180/45 = 4 x 375mls = 1.5 litres per wash**
- **2 washes a day = 3 itres a day of detergent required**

Milking equipment cleaning practices observed on farms (%) with Chlorate & TCM residues

Factor	Chlorate (0.001mg/kg)	TCM (0.0015mg/kg)
Own water supply	92	100
Disinfect own well-chlorine	0	14
Inadequate detergent rinse	83	80
Chlorine/liquid used on machine	77	71
Not rinsing detergent correctly	36	43
Re-using detergent >once	14	50
Additional chlorine to main wash	7	29
Chlorine to final rinse	7	14
Chlorine/liquid used on bulk tank	83	100
Detergent purchase > 3 mts	79	83

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Choosing a wash routine

- **The wash routines outlined (A, B, C, and D) represent the most commonly used routines in Ireland**

- **Routines which incorporate the use of more regular acid cleaning (C, D) are highly effective in maintaining low bacterial numbers on any size milking system; however this system is more suited to plants with automatic wash systems in place due to the extra safety precautions necessary with the use of acid**

- **Liquid products are more suitable than powder products where automatic cleaning is in place**

- **Cold wash systems (B, C) which may contain liquid or powder products require a higher working solution of sodium hydroxide and require increased contact time to be effective as they do not contain chlorine**

- **If milk meters are in place, daily cleaning with hot water is required**

- **Details of the washing systems are available on the Teagasc website**

Routine A: Hot Detergent-steriliser cleaning

Detergent-steriliser (Sodium Hydroxide and Sodium Hypochlorite

1. Wash outside of clusters, attach jetters and remove milk filter
2. Rinse plant with 14 litres (3gls) of water per unit (cold or warm)
3. Add **liquid detergent-steriliser** at the manufacturers recommended usage rate to hot water (65-75°C), allowing 9 litres (2gls) per unit
4. Circulate the hot solution for 8-10 min, allowing first 5 litres to run to waste, the solution may be retained for the 2nd daily wash (if retained; discard solution after the second daily wash)
5. Rinse the plant immediately after the main wash cycle with 14 litres (3gls) of cold water per unit
6. Ensure the system is drained before the next milking

- ***Once weekly**:* After step 2, add an acid descaler (**milkstone remover**) at the manufacturers recommended usage rate to hot or cold water, allowing 9 litres (2gls) of water per unit
- Circulate the solution for 8-10 min and discard
- Rinse plant with 14 litres (3gls) of cold water per unit
- Continue with steps 3, 4, 5 and 6

- **Optional extra**: After step 5 is complete, **Peracetic acid** may be added twice daily as a sterilizer to **an additional** rinse water cycle
- (weekly acid descaling with milkstone remover no longer required in this instance)

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Routine B: Cold cleaning

Detergent powder (sodium hydroxide, chlorine free)

1. Wash outside of clusters, attach jetters and remove milk filter
2. Rinse plant with 14 litres (3gls) of cold water per unit
3. **Add the detergent powder** at the manufacturer recommended usage rate to cold water, allowing 9 litres (2gls) per unit
4. Circulate the solution for 8-10 min; allowing first 5 litres to run to waste. Solution may be retained for the second daily wash. **Leave the stain of the solution in the milking plant until just before the next milking**
5. Just before the next milking, rinse with 14 litres (3gls) of cold water per unit
6. Ensure the system is drained before milking

- **Once weekly:** After step 2, add an Acid descaler (**milkstone remover**) to hot or cold water
  - **Circulate the solution for 8-10 min and then discard**
    - » **Rinse plant with 14 litres (3gls) of cold water per unit**
      - **Continue with steps 3, 4, 5 and 6**

- **Once weekly**: At step 3, add Sodium hypochlorite (**chlorine**) to the detergent powder solution at the manufacturer recommended rate in **hot water** (65-75ºC). On this occasion rinse the wash solution from the plant immediately after the wash cycle is complete.

- **Optional extra**: After step 5 is complete, **Peracetic acid** may be added twice daily as a sterilizer to an **additional** rinse water cycle
- **(weekly acid descaling with milkstone remover no longer required if this option is used)**

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Routine C: Non-chlorine cleaning

Detergent /acid cleaner
(Sodium hydroxide and phosphoric acid)

1. Wash jetters and outside of clusters and remove milk filter
2. Rinse plant with 14 litres (3gls) of water per unit (cold or warm)
3. After the morning milking, **add liquid detergent (non-chlorine)** at the manufacturer recommended usage rate to hot (65-75°C) or cold water, allowing 9 litres (2gls) per unit
4. Circulate the solution for 8-10 min; allowing the first 5 litres to run to waste. When circulation is complete, discard the solution. **Leave the stain of the solution in the milking plant until just before the next milking**
5. Just before the next milking, rinse with 14 litres (3gls) of cold water per unit
6. Ensure the system is drained before milking

- A**fter each evening** milking replace the liquid detergent (non-chlorine) product with a **Liquid Acidic cleaner** added at the manufacturer recommended usage rate to cold or **hot water** (65-75°C), allowing 9 litres (2gls) per unit
- Circulate for 8-10 min; allowing the first 5 litres to run to waste and then discard. Follow immediately with a rinse

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Routine D: Hot Detergent-steriliser/acid cleaning

(Sodium hydroxide-Sodium Hypochlorite and phosphoric/nitric acid)

1. Wash jetters and outside of clusters and remove milk filter
2. Rinse plant with 14 litres (3gls) of water per unit (cold or warm)
3. After the **morning milking**, **add liquid detergent-steriliser** or powder product containing sterilizer at the manufacturer recommended usage rate to hot water (65-75°C), allowing 9 litres (2gls) per unit
4. Circulate the solution for 8-10 min, allowing the first 5 litres to run to waste, and discard when circulation is complete
5. Rinse the plant immediately with 14 litres (3gls) per unit of cold water
6. Ensure the system is drained before the next milking

- After each **evening milking:** replace the detergent-sterilizer product with a **Liquid Acidic cleaner** at the manufacturer recommended usage rate to **hot water** (65-75°C), allowing 9 litres (2gls) per unit
- Circulate the solution for 8-10 min allowing the first 5 litres to run to waste and discard when circulation is complete
- Continue with rinse and drain

Non-chlorine cleaning

- Now specified by some milk processors
- First country to adopt new cleaning protocol. Little information available
- Option to be considered if farmer has TCM problem
- Routines more expensive-some individual products double the price of existing detergent/steriliser products
- To help industry Moorepark undertaking evaluation of non-chlorine cleaning protocols- Trials on-going

Milking machine wash routines on test at Moorepark containing minimum chlorine to reduce chlorate/TCM residues and maintain low bacterial counts

Weekly Wash routine	Chemical Cleaning products			Wash time	
	Name	Main ingredient	Usage-weekly	AM	PM
Biocel Chlorine free	Multisan CF	Sodium hydroxide (25%)	Main wash AM	Hot x 7	-
	Serpent	Acid-Acetic/peracetic, hydrogen peroxide	Main wash PM	-	Cold x 7
	Boost	Hydrogen peroxide	Added to AM wash twice weekly	Hot x 2	-
Cold wash Powder Minimum chlorine	Powder, no chlorine	Sodium hydroxide (76%)	Main wash AM & PM	Hot x 1	Cold x11
	Acid Descaler	Acid-phosphoric	Once weekly	Hot x 1	-
	Detergent/ Steriliser liquid	Sodium hydroxide (≥15%) chlorine (≤3.5%)	Once weekly	Hot x 1	-
Diversey Chlorine free All in one product	Divosan OSA-N	Acid –Nitric, glycolic, octanoic, octenylsuccinic	Main wash AM & PM	Hot x 4 Cold x 3	Cold x7
Ecolab Chlorine free	LactivateClean	Sodium hydroxide (40%)	Main wash AM & PM	Cold x 3	Cold x 7
	LactivateAcid	Acid-phosphoric, hydrogen peroxide	Main wash AM	Hot x 4	-
GleeColl Minimum chlorine	Liquid detergent	Sodium hydroxide (25%)	Main wash AM & PM	Hot x 4 Cold x 2	Cold x 7
	Peracetic acid	Acid-Acetic/peracetic, hydrogen peroxide	Final rinse twice daily	Cold	cold
	Detergent/ Steriliser liquid	Sodium hydroxide (≥15%) chlorine (≤3.5%)	Main wash AM Once weekly	Hot x 1	-
Grassland Agro Chlorine free	Hypracid One	Acid-Methanesulfonic	Main wash AM & PM	Hot x 6	Cold x 7
	Hypral One	Sodium hydroxide (28%)	Main wash AM Once weekly	Hot x 1	-
Kilco Chlorine free	AUTOSAN BLUE	Sodium hydroxide (21%)	Main wash AM & PM	Hot x 4	Cold x 7
	AUTOSCAN RED	Acid-phosphoric	Main wash AM	Hot x 3	-

Non-chlorine cleaning

- Critical to re-calibrate auto washer if changing to higher caustic product (non-chlorine)
- Hot water is vital if no chlorine
- Recycling detergent for second wash no longer an option
- Bulk tank first step
- New routines being put forward by other companies

Effect of milk cooling temperature, pre-cooling protocols and storage time on milk microbiological quality

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Introduction

- There is limited information on the relationship between storage time of milk and the microbial quality of milk

- Previous studies – laboratory based-addition of fresh milk throughout storage not accounted for

- EU food hygiene legislation- Directive 853/2004
  "Immediately after milking, milk must be cooled to not more than 6°C if collection is not daily"

  - Cooling to lower temperatures may be critical if storing milk for 3/4 days

- From an industry point of view there are economic savings if milk collection time on farm could be extended to 3 days without impacting on milk quality

- *Two studies were undertaken to measure the effect of storage conditions on milk quality similar to that observed on farms*

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Materials and Methods

Trial 1: Objective:

- **To investigate the effects of milk storage temperature (2°C, 4°C and 6°C) and storage time (0 - 96 h) on the microbial quality and functional properties of bulk tank milk**

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Materials and Methods

- 3 X 4,000 L bulk milk tanks
- 5.5hp compressors
- Single stage plate cooler
- Milk diverted from parlour -3 ways
- Milk added twice daily

Storage Trial

2°C

4°C

6°C

- **Milk supply at milking diverted three ways**
- **2 six week periods-Mid & Late lactation**
- **3 temperatures (2°C, 4°C and 6°C)**
- **Milk was stored for 96h with fresh milk added at each milking**
- **Milk analysis-TBC, Psychrotrophic, Thermoduric, Lipolytic & Proteolytic count**

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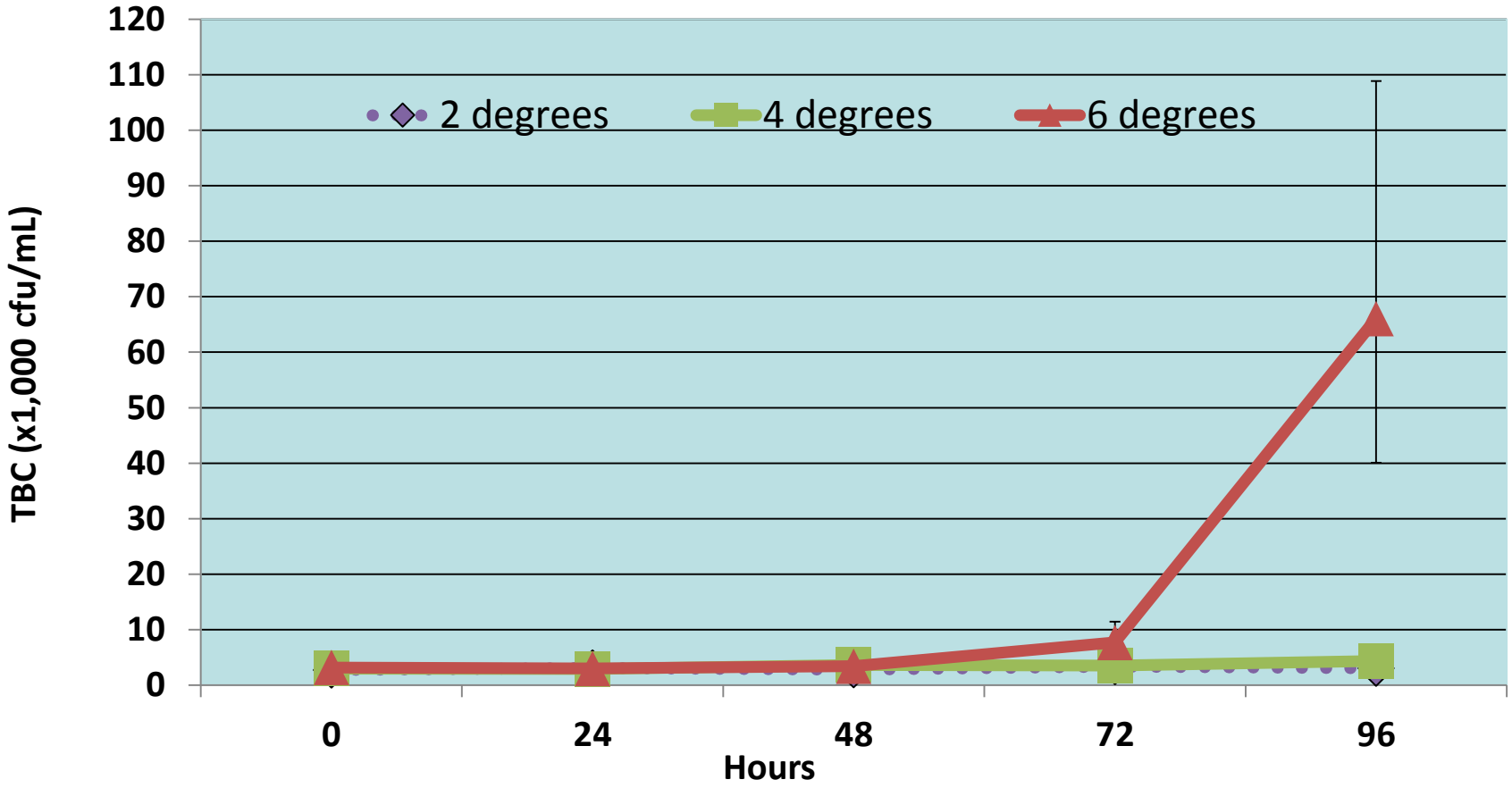
Results: Total Bacteria Count



No difference between temp. up to 48 h

Rapid growth of bacteria at 6°C after 48 h

Large variability in bacterial growth – 96 h at 6°C

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Conclusions

- First study to investigate the effect of bulk tank milk storage conditions -- to mimic farm conditions
- Bulk tank milk can be stored at 2°C or 4°C for up to 96 h
- Not all dairy farmers will achieve these results as -milk entering the tank had minimal bacterial contamination (mean TBC = 3,162 cfu/mL)
- Good teat prep & cluster cleanse& good parlour /tank wash routine
- Functional properties of milk not impacted at 96h
- Influence of tank design, compressor size and plate cooler efficiency- IMPORTANT
- Rate of cooling may be critical

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Trial 2. Measure the effect of cooling rate on milk quality

- **Objective :**
  - **To test the effect of 3 pre-cooling protocols**
    - **No plate cooling**
    - **Single stage cooling**
    - **Double stage cooling**

    on the bacterial numbers in milk during storage

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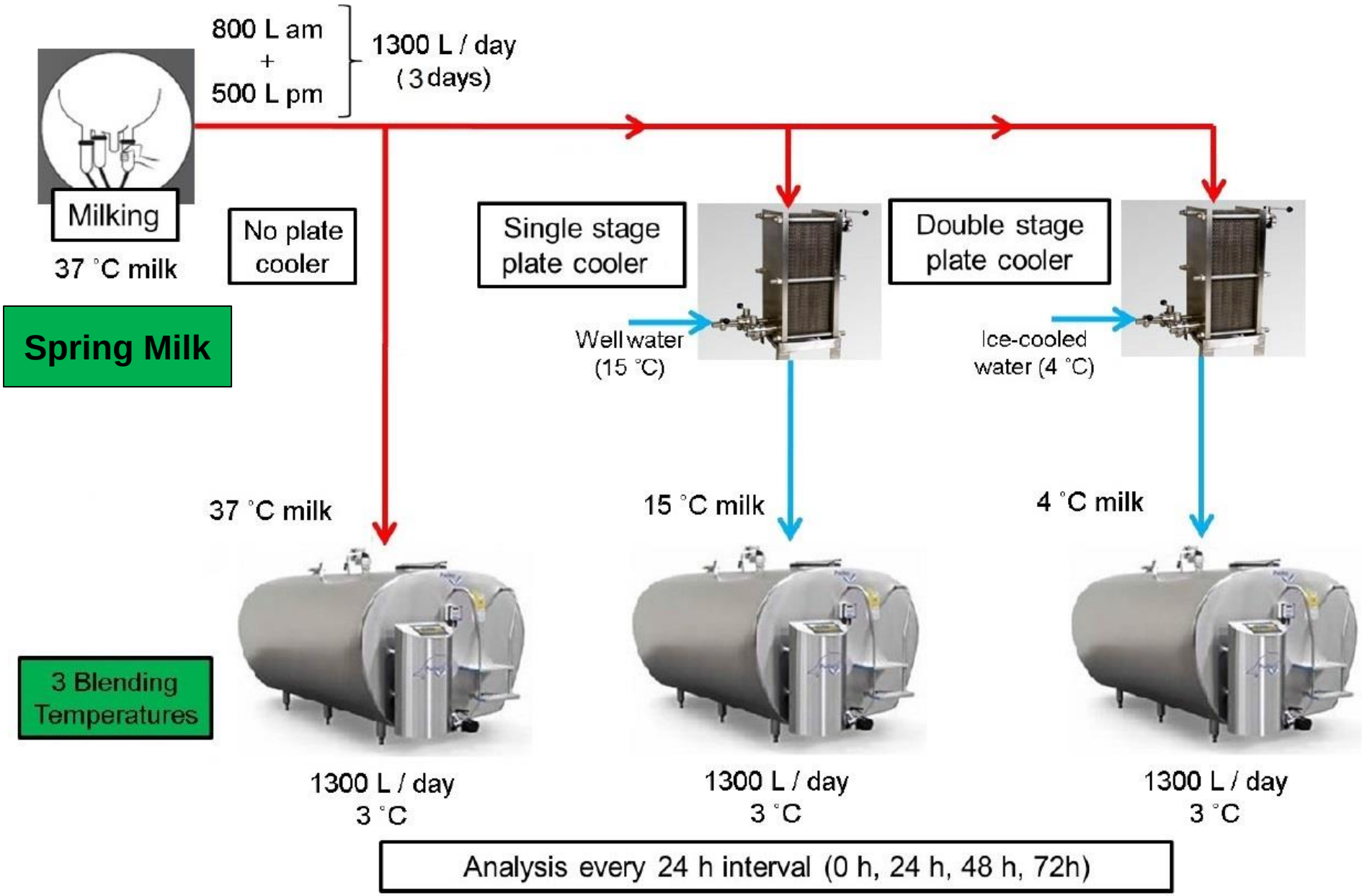
Experimental Design



Microbiological Analysis (cfu/ml)

Cooling Systems

Cooling System	NP	SP	DP	Significance
TBC	4914	4790	4040	NS
Psychrotrophic Bacteria	1722	1441	1346	NS
Thermoduric Bacteria	7	7	9	NS
Thermophile Bacteria	6	6	3	NS
Lipolytic Bacteria	2086	2072	2051	NS
Proteolytic Bacteria	1840	1735	1953	NS

Pre-cooling system did not have a significant impact on bacterial counts
Presumptive *Bacillus cereus*- 5% of samples, SRC <1% of samples

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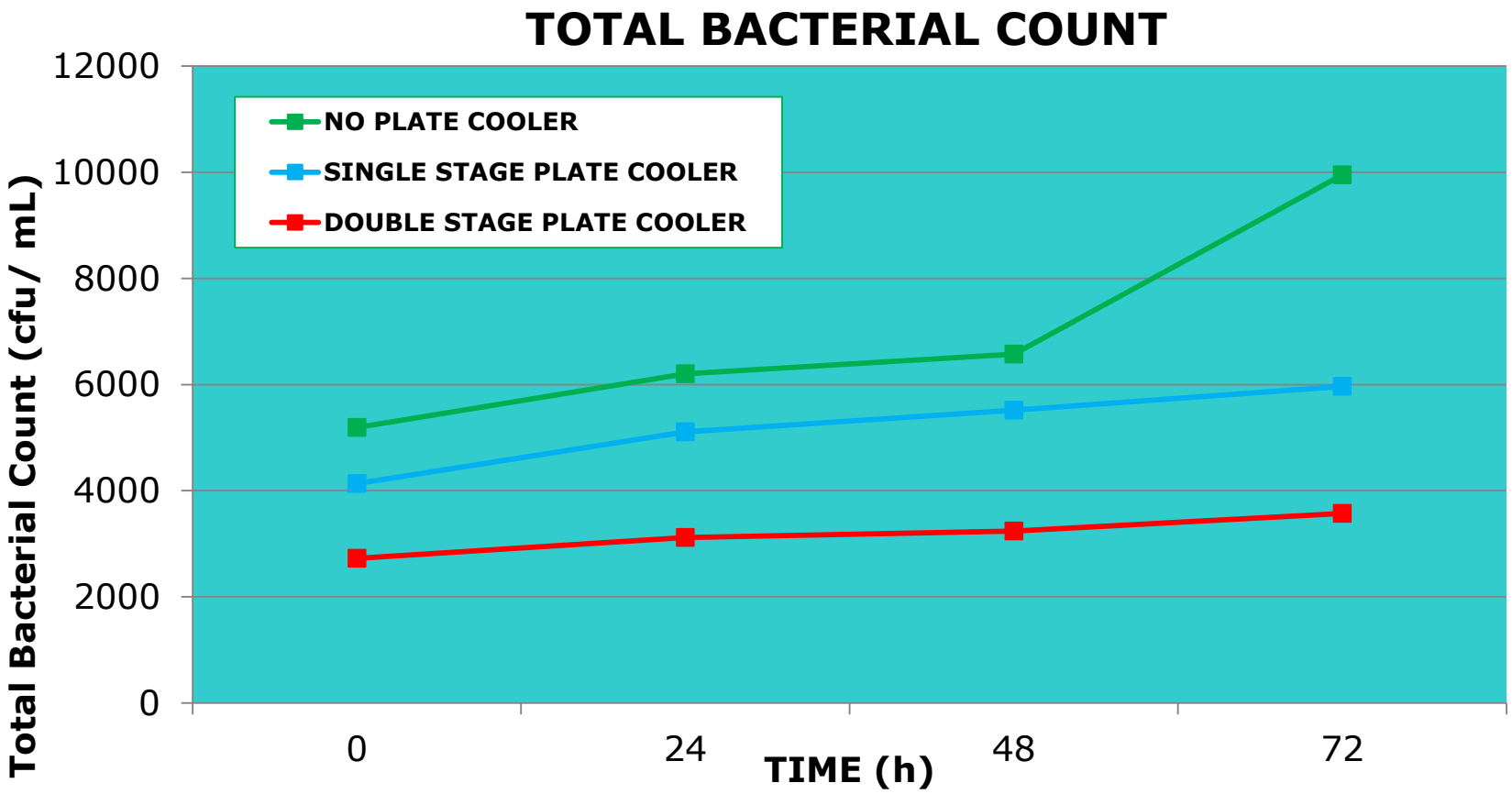
Results: Microbiological Analysis



Significantly affected by time and not by rate of cooling

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Conclusions

- Milk ‘pre-cooling protocol’ had no significant impact on the microbial quality of milk when cooled to 3 ^{o}C & stored for 72h
- Very high quality milk entering tanks-not all farmers achieving this
- Pre-cooling protocol may be more critical if;
  - Initial milk of poor quality
    - or less efficient tank cooling
- Milk bacterial counts increased with storage time- but within acceptable guidelines
- Energy data recorded

Storage -Peer reviewed publications

J. Dairy Sci. 99:3367–3374
http://dx.doi.org/10.3168/jds.2015-10495

The effect of storage temperature and duration on the microbial quality of bulk tank milk

A. O'Connell,*† P. L. Ruegg,† K. Jordan,‡ B. O'Brien,* and D. Gleeson*[1]
*Teagasc, Livestock Systems Research Department, Animal and Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork, Ireland
†Department of Dairy Science, University of Wisconsin-Madison, Madison 53706
‡Teagasc Food Safety Department, Food Research Centre, Moorepark, Fermoy, Co. Cork, Ireland

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The effect of storage conditions on the composition and functional properties of blended bulk tank milk

A. O'Connell,*† A. L. Kelly,‡ J. Tobin,§ P. L. Ruegg,† and D. Gleeson*[1]
*Teagasc, Livestock Systems Research Department, Animal and Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork, Ireland
†Department of Dairy Science, University of Wisconsin-Madison, Madison 53706
‡Department of Food and Nutritional Sciences, University College Cork, Cork, Ireland
§Food Chemistry and Technology Department, Teagasc Food Research Centre, Moorepark, Fermoy, Co. Cork, Ireland

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Overall conclusions

- Milk quality at farm level is determined by :
  - Hygienic condition of facilities
  - Cleanliness of teats prior to milking
  - Effective milking equipment cleaning protocol
  - Correct storage of milk

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Actions implemented at Moorepark to improve the quality of milk on Irish dairy farms

- Milk Quality booklet
- DVD-training purposes/website
- Training of milk quality advisors
- Washing procedures defined and available to all farmers-website
- Chemical analysis conducted on all cleaning products used on Irish farms-website

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Thank you for your time