Extending the Shelf Life of Liquid Sheep Milk Products

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Ministry of Business, Innovation & Employment

Boosting exports of the emerging NZ dairy sheep industry

MBIE Programme (October 2013 – September 2019)

Milk composition

Increased milk production

Health benefits

Environmental footprint

Kingsmeade

SPRING SHEEP NEW ZEALAND

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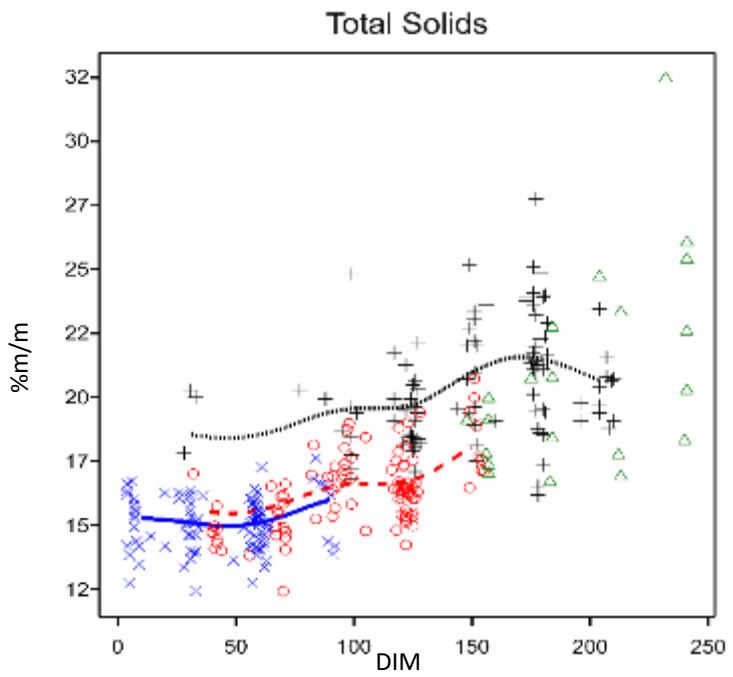
Background and Challenges

- It has not been possible to produce liquid sheep milk products with longer shelf-life (beyond pasterisation)

- Sheep contains high levels of fat, proteins, minerals and total solids – vary throughout the season



- Factors influencing the milk heat stability
  - Milk is an equilibrium system
  - Changes in pH and mineral balance inducing protein aggregation
  - Heating milk induces whey protein denaturation, mineral balance and milk pH

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Research questions

- What do we know about the heat stability of sheep milk?
- Can we improve sheep milk heat stability (beyond pasterisation) by controlling the mineral balance and pH stability?
  - Can we find a lab method to mimic high heating processing?
- Can we transfer the lab results to pilot-scale?
- How does milk composition (e.g. fat, protein, total solids) affect heat stability?
- Can we apply the technology to all sheep milk produced by different suppliers at different times?

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Heat treatment of liquid milk

Pasteurisation
(1-2 weeks shelf-life)

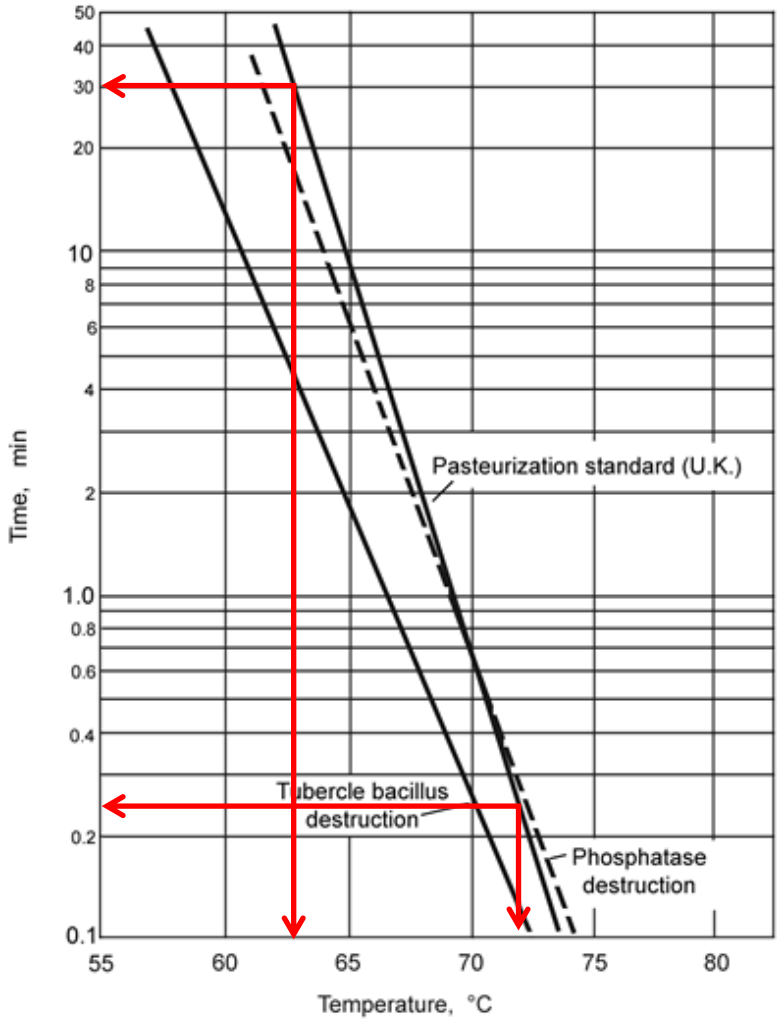
Definition: AS 3993 - 2003

A heat treatment process in which every particle of milk or liquid dairy product is heated to not less than the specified temperature and held at that specified temperature for not less than a specified time with the aim of:

- Avoiding public health hazards arising from pathogenic microorganisms associated with milk
- Reducing spoilage organisms

AND

- *minimise physical, chemical & organoleptic changes!*



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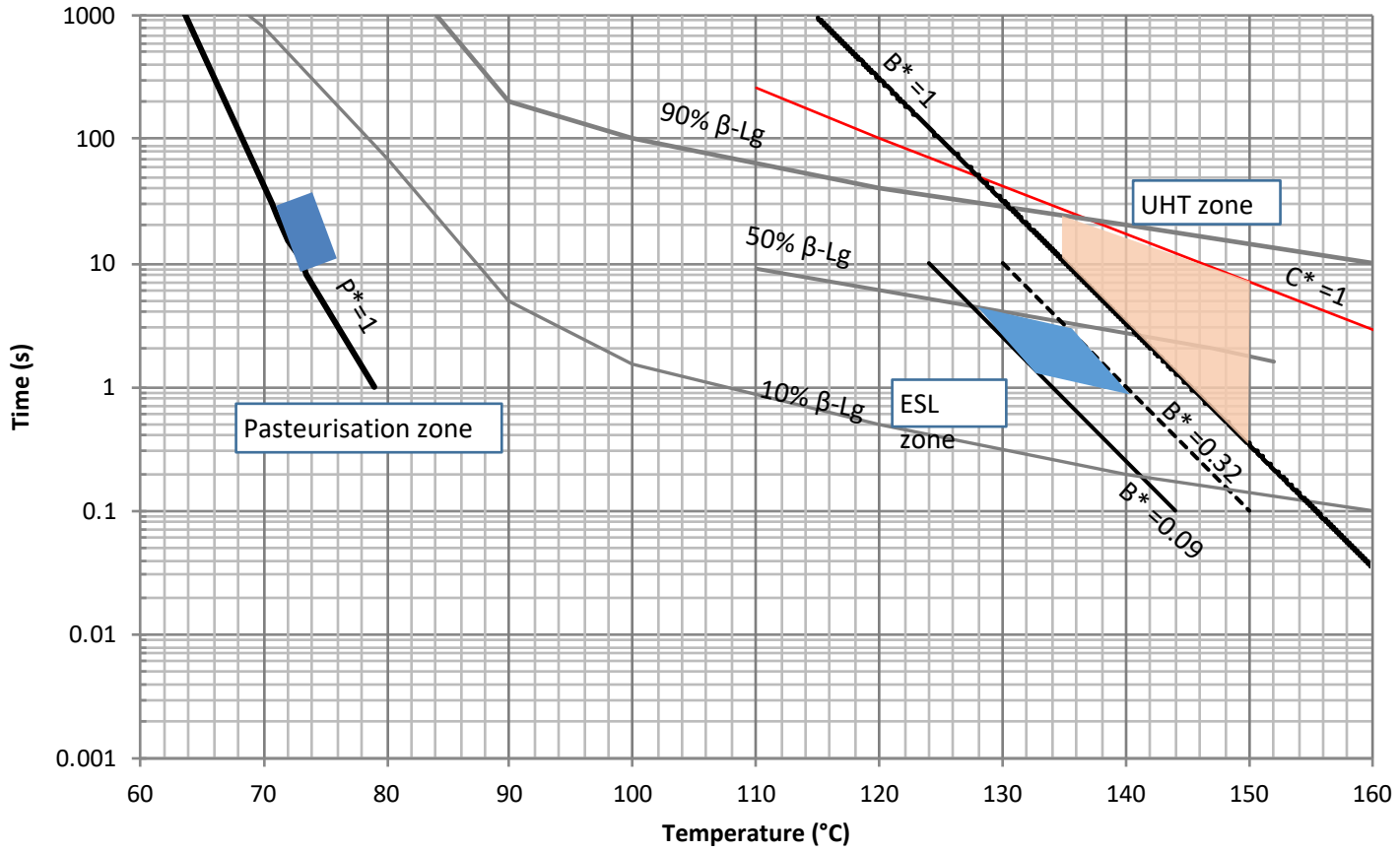
Heat treatment of liquid milk



Choice of heat treatment conditions utilises knowledge of the different destruction rates for microbes, enzymes and chemical changes.

Increased heat treatment:

- Changes in flavour and taste
- Changes in functional properties
- Reduced biological activity

Deeth & Lewis, 2017, High Temperature Processing of Milk and Milk Products & Kessler (2002) Food & BioProcess Engineering – Dairy Technology

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Heat treatment of liquid milk

Ultra-high temperature processing (UHT)

- Heating above 135 °C / < 1 – 2 s
- Kill spores – sterilization
- Cooked, caramelised flavours
- Shelf life 6 – 9 months at ambient temperature

Extended shelf-life processing (ESL)

- Sub-UHT conditions e.g 123 – 140 °C / < 1 – 5 s
- Kill all vegetative cells and most of the psychrotrophic spores e.g. *B cereus*
- Improved flavour profile over UHT
- Aseptic/clean packing to avoid post processing contamination
- Shelf life 30 – 60 days at 4°C

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Key findings

- Sheep milk has poor heat stability

Sample	Start pH	Heat Coagulation Time (s)	Ethanol Stability (%)
Raw whole	6.57 @ 17.1 °C	375	52
Skim unheated	6.65 @25.5 °C	388	54
Skim, 72 °C, 15 s	6.70 @ 20.4 °C	376	52
Skim, 85 °C, 180 s	6.67 @ 19.7 °C	151	52

* Typical values for cow milk: HCT > 500 s, ES – 60-80%

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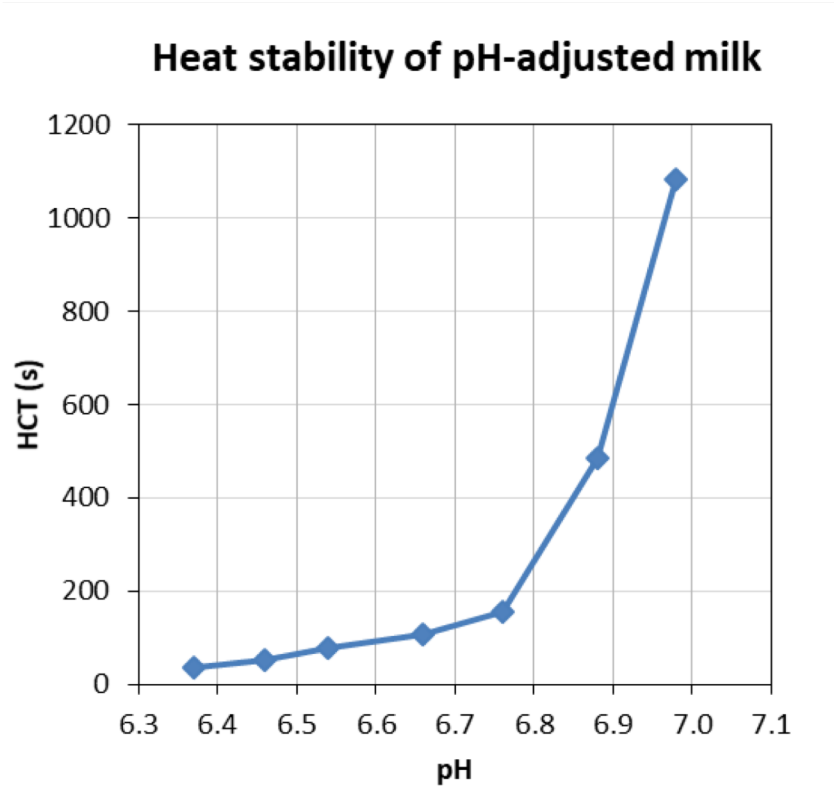
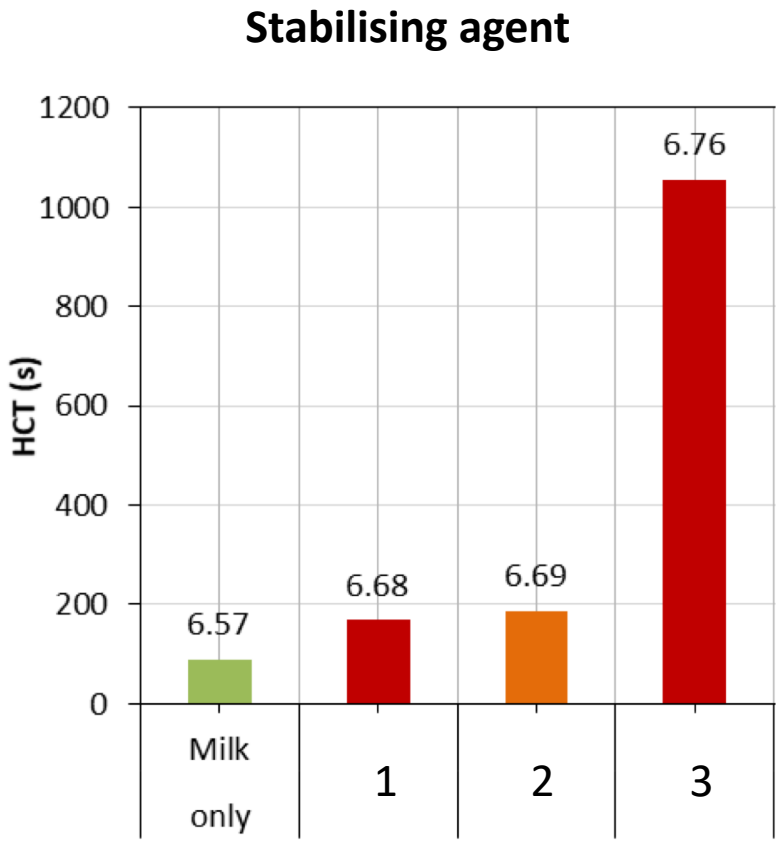
Heat stability can be improved by shifting pH





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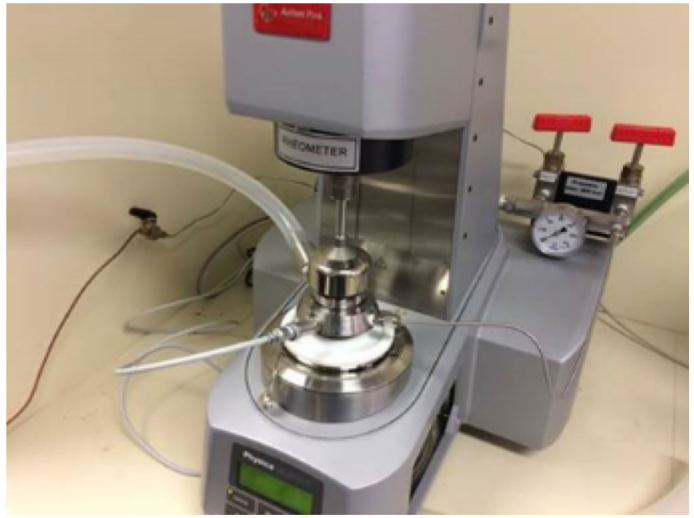
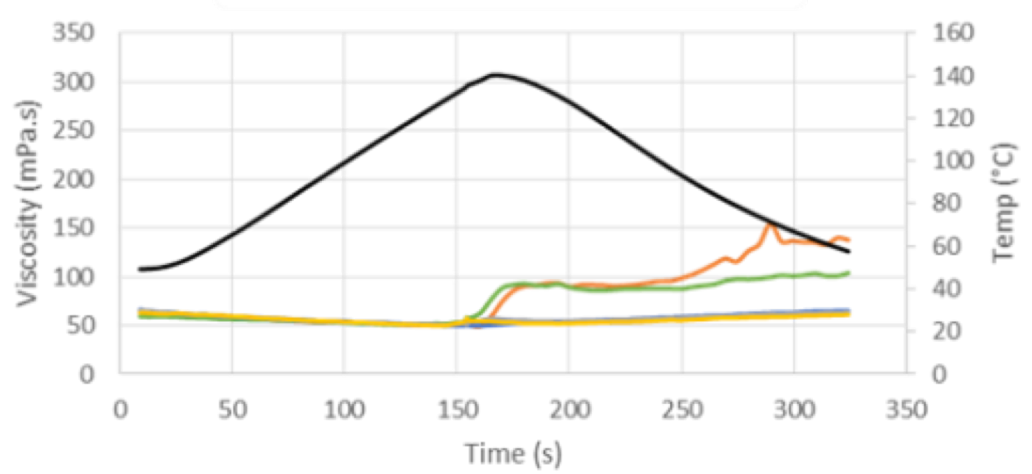
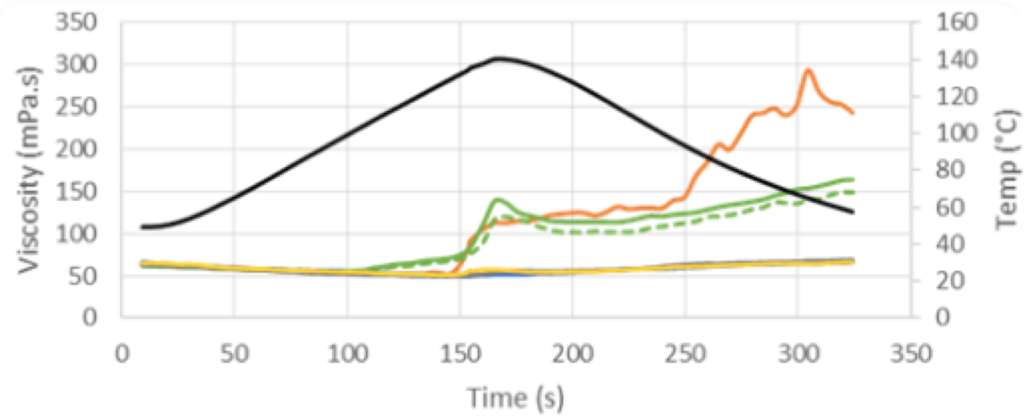
Starch cell to simulate UHT/ESL conditions







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Pilot trials successfully completed

- UHT trial in March 2018 at AgResearch
  - Skim milk
  - Reduced protein skim milk, by diluting with permeate
  - Whole milk, by recombining with cream, then homogenised
- ESL and UHT trials in November 2018 at AgResearch
  - Test our best conditions
  - Compare ESL and UHT processing (120 °C and 140 °C)
- ESL and UHT trials in March 2019 at FoodBowl

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Learnings

- Sheep milk has poor heat stability. It behaves differently from different suppliers, and at difference times of the season.
- The heat stability of sheep milk can be improved by balancing mineral equilibrium and controlling the pH stability.
- An ESL product is more easily achieved than a UHT product.
- ESL and UHT processing may need to be specifically optimized.

Skim milk

Full fat milk