Low-temperature centrifugation of milk for manufacture of raw milk cheeses: impact on milk microflora and cheese yield

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Background

Milk centrifugation is occasionally applied to remove *Clostridia's* spores that may cause the "late blowing" of cheese. High centrifugal force (8,000-10,000*g*) and temperature around 50-60°C are usual operating conditions (Mc Carthy, 2011). During milk centrifugation, spores and bacterial cells are concentrated and periodically ejected (15-20 min) as a sludge. Normally, the sludge represents 2.5-3.5% of the processed milk volume and contains up to 12-13% of protein (casein). To avoid this loss of solids, that would result in a loss of cheese yield, the sludge is sterilized and re-added to cheese milk (Gesan-Guiziou, 2010).

Can we use low temperature centrifugation in a raw milk cheese technology ?

In the manufacture of raw milk cheeses, the centrifugation process shall be performed at temperature **below 40°C** and no sterilized sludge can be re-added to maintain the raw milk requisite. Certainly, both these limitations negatively affect cheese yield.

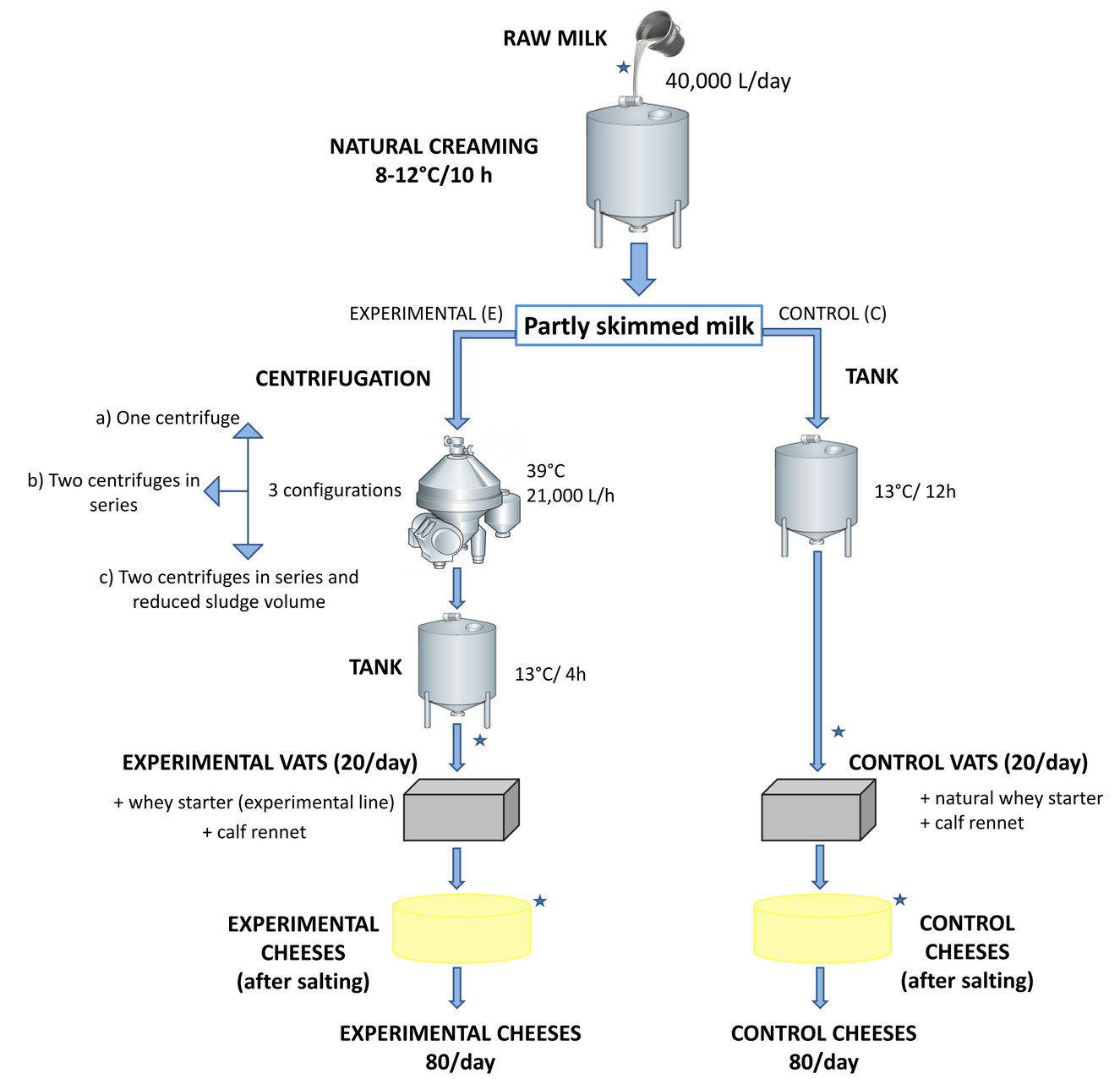
The **aim** was to asses the impact of adopting milk centrifugation process conducted at **39°C** and with sludge elimination in the production of a raw-milk hard cheese.

Methods

The experimentation was carried out in a cheese factory following the traditional process of raw milk hard cheese. Three different process configurations were evaluated over a three-week period each, and the efficiency was assessed with respect to not-centrifuged milk from the same batch. The sampling points are identified with a blue star in the experimental design outline and the following analysis were performed:

1. Gross composition of milk by means of Milkoskan 134 (Foss, Denmark)
2. Cheese yield (amount of obtained cheese with respect to the control)
3. Determination of total bacterial count (Milk Plate Count Agar), coliforms (Violet Red Bile Agar) and spores (MPN)
4. Determination of lactic acid bacteria by impedance analysis using a BacTrac 4300® Microbiological Analyzer system (Sylab) using the method of Bancalari et al., 2016.
5. Confocal laser scanning microscopy: milk samples were stained with Nile Red to detect the core of fat globule (D'Incecco et al., 2018)
6. Confocal laser scanner microscopy to observe the shape of bacterial cells stained with Hoechst 34580

Experimental design



Results

1 centrifuge

+
- No significant influence on milk fat globule characteristics
- No changes in milk composition
- Lowest cheese yield loss

−
- Spore removal efficiency 95,9%
- No significant influence on TBC and Coliform count
- Partial and **selective** removal of LAB

2 centrifuges

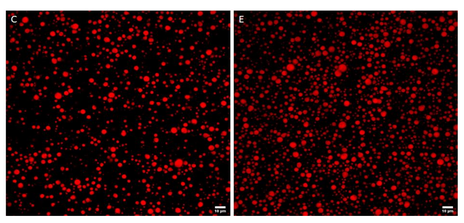
+
- Spore removal efficiency 97,9%
- Positive influence on TBC and Coliform count

−
- Significant decrease in milk components
- Negative influence on fat globules structure (lower diameter and area)
- No significant influence on TBC and Coliform count
- Partial and **selective** removal of LAB

2 centrifuges- improved

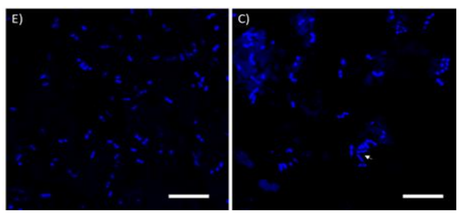
+
- Highest spore removal efficiency 98,2%
- Significant influence on TBC and Coliform count
- Small cheese yield loss

−
- Negative influence on fat globules structure (lower diameter and area)
- Partial and **selective** removal of LAB



Confocal laser images of fat globules (red) of **C**ontrol (left) and **E**xperimental (right) vat milk. Bars are 10µm in length.

Single centrifugation did not cause a significant difference in fat globule characteristics. Conversely, diameter , area and circularity of fat globules were lower in E samples obtained with 2 centrifugations



Confocal laser scanning microscopy of bacteria cells of **E**xperimental (left) and **C**ontrol (right) samples. Bars are 10µm in length.

The impedometric method allowed to hypothesize that centrifugation removed LAB selectively, retaining cells with spherical shape more than road shaped ones

Conclusion

The results showed that low temperature centrifugation of milk can be successfully applied in the manufacture of raw milk cheeses. Nevertheless, a compromise has to be reached between spore removal efficiency and protein loss because these two parameters have shown an opposite trend while changing centrifugation and sludge volume. The data collected suggest that using two centrifuges in series can be a better solution as long as the sludge volume is kept low. The major inconvenience of adopting this process deals with the removal of rod-shaped bacteria that causes the unbalancing of NSLAB species in cheese milk. This could impact on proteolysis and lipolysis, as well as on flavour behaviour that, however, will be evaluated in cheeses at the end of ripening.

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