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Reduction of Cheddar cheese ripening time through the addition of glucose

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Introduction
Ripening of cheese consists of complex microbial interactions between starter lactic acid bacteria (SLAB) and non-starter lactic acid bacteria (NSLAB). One of the key microbial interactions is growth of NSLAB by utilization of metabolites (various sugars) released from SLAB during cell death. The establishment of a high NSLAB level in cheese is slow, taking several months. Therefore, significant cost saving would be achieved if a high level of NSLAB could be established in a shorter time. This study, using broth models and cheese trials, was performed to optimize and accelerate the NSLAB growth interactions.

Materials and Methods
Broth models (adapted from Adamberg et al., 2005) as well as studies in cheese (based on Ortakci et al., 2015) were developed.

1) Broth models were developed by investigating the growth of a commercial SLAB containing Lactococcus lactis subsp. cremoris and subsp. lactis culture (10% CFU/mL), in LM17 broth with and without supplementation of glucose for 48 h, by measuring the optical density (OD) at 600 nm every hour using a microtiter plate reader (Biotek).

2) Cheddar cheese was manufactured using the same commercial SLAB, with fast cell lysis properties. Glucose was added (0.5 %) at the milking step in an attempt to increase the growth of NSLAB. Cheddar cheese was then ripened at 10°C for 120 days.

3) Cheddar cheeses were analyzed using standard methods (Figure 2) to measure different levels of NaCl, moisture (7 days after manufacturing). Furthermore, lysed cells, pH, Aw, and microbial counts of SLAB and NSLAB were also measured (immediately after manufacturing and after 5, 9, 13 and 17 weeks ripening).

Results

The broth models showed that the 5 % salt in moisture (S/M) was sufficient to inhibit the utilisation of glucose by the SLAB (Figure 3).

Furthermore, lysed cells, pH, Aw, and microbial counts of SLAB and NSLAB were also measured (immediately after manufacturing and after 5, 9, 13 and 17 weeks ripening).

NSLAB increased from levels under detection limit (105 CFU/g of cheese) to levels comparable with other starter LAB (Figure 3). Results indicated no differences on the microbiota in cheeses supplemented with 0.5 % glucose (Figure 5).

However, the pH became at similar levels, independently of the cheese. After 13 weeks all cheese had pH values inside the desired range for premium quality of Cheddar cheese.

Future perspectives

Despite the fact that glucose was depleted from the supplemented cheeses by SLAB, investigation will still be performed using those cheese, in order to understand the dynamics involved in bacterial interaction when adding the selected SLAB.

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Lessons learned by supplementing Cheddar cheese with glucose:

Results indicate that in order to accelerate the cheese ripening by supplementing with sugars, it is necessary to screen for sugars exclusively utilized by the NSLAB:

At the curd milking, glucose was added to increase the growth rate of NSLAB.

One third of the added glucose was retained in the curd (when salt-in-moisture = 6.0 – 6.3 %); however, 1 week post-manufacture, no detectable glucose was present in the cheese. As NSLAB levels were still under the detection limit (105 CFU/g of cheese) after 1 week post-manufacture, it is concluded that SLAB were responsible for the glucose depletion.

Surprisingly, the broth models showed that at 5 % salt-in-moisture, SLAB were unable to utilize glucose.

However, the pH became at similar levels, independently of the cheese. After 13 weeks all cheese had pH values inside the desired range for premium quality of Cheddar cheese.

Bacterial cell lysis was estimated by assaying for intracellular X-prolyl dipeptidyl aminopeptidase activity (PepX) in aqueous extracts of the cheese (Figure 6). Results indicated no increase of the level of lysed cells during ripening until week 13, which supports the findings of the microbiological analyses.

Nevertheless, it seems that cheeses supplemented with glucose may have a relatively higher lysis until it became stable and at the same level of the related controls, with no glucose added. Lysis was lower and became stable faster on the cheeses with higher level of salt.

A certain degree of instability was also noted by investigating the pH as well as the water activity (Aw) of the cheeses during the ripening period (Figures 7 and 8, respectively).

References

Ortakci et al., 2015. J. Dairy Sci. 98:7460-7472
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