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Cheese powder without emulsifying salt – processing parameters and stability

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Objectives

- To study the effects of processing parameters on stability of cheese feed for cheese powder production
- To assess the potential of mechanical and thermal treatment as alternative to emulsifying salt (ES) addition

Introduction

Cheese powders are used in the food industry as natural functional and flavour ingredients in applications such as biscuits, savoury snacks, bakery products, sauces, dressings, ready meals and processed cheese, typically added at levels of 2-12%. In cheese powder production, cheese is comminuted and melted with addition of water and ES. This cheese slurry, ***cheese feed***, is then heat-treated and finally most of the water is removed by spray drying.

Emulsifying salts, primarily sodium phosphates, are added to create an emulsion that remains stable until spray drying and also to ensure a final powder with good storage quality.

On the market there is a growing demand from consumers and authorities for food produced without additives, including ES, and currently especially sodium.

Besides addition of ES, parameters such as the characteristics of the cheeses used, addition of other dairy ingredients and processing parameters may affect the stability of the cheese feed. An increase in mechanical treatment during processing will furthermore lead to a decrease in fat globule size, which will slow down fat separation and provide a larger surface area for interactions between fat and protein.

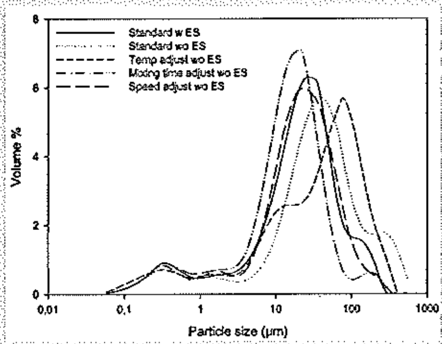

Figure 1: Particle size distributions measured in cheese feeds. w/wo: with/without; ES: emulsifying salt

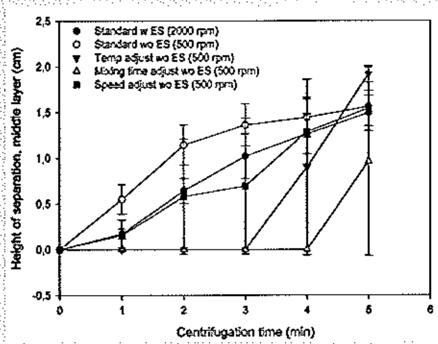

Figure 2: Stability by centrifugation. Analyzed by performing consecutive centrifugations of one minute duration at the speed indicated in the legend in the figure. w/wo: with/without; ES: emulsifying salt

Results and discussion

Changing the processing parameters during production of cheese feed in the Stephan cooker influenced the analyzed properties of the cheese feed. The analysis of particle size reveals that removal of the ES from the standard feed leads to an increase in particle size, whereas increasing the mixing time before heating leads to a decrease in particle size (Figure 1).

The highest similarity in particle size between the standard feed with ES and a feed without ES is seen for the feed prepared using an increased mixing speed (Figure 1). However, when comparing with the stability by centrifugation, this feed appears to be only slightly more stable than the standard feed without ES (Figure 2). Furthermore, the measurement of apparent shear viscosity shows that increased mixing speed leads to a very low viscosity compared to the standard with ES (Figure 3).

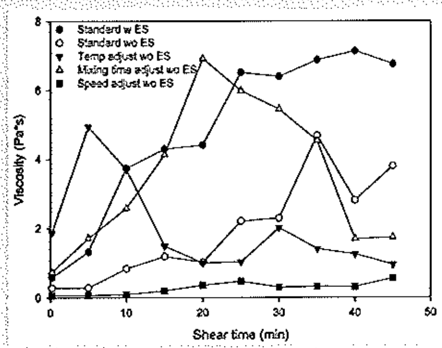

Figure 3: Viscosity of cheese feed analyzed under steady shear (15 s^{-1}). w/wo: with/without; ES: emulsifying salt

A decrease in particle size is often linked to an increase in emulsion stability, which also seems to be true for cheese feed without ES. The cheese feed prepared with increased mixing time has smaller particle size (Figure 1), higher stability by centrifugation (Figure 2) and a viscosity profile quite similar to the standard cheese feed with ES (Figure 3). The increase in viscosity over time in the feed with ES is thought to be due to building of a protein structure as suggested by Lee et al. (2003). The similar build-up of structure leading to increased viscosity of the cheese feed observed when mixing time was increased suggest that the emulsification properties of the proteins may be improved by this parameter change, and similar maximum values for the viscosity is obtained. However, after approx. 20 minutes of steady shear the viscosity of the feed without ES starts to decrease (Figure 3), implying that the structure is broken down again.

Heating temperature is highly confounded with mixing time in this study, since the increased heating is obtained by prolonging the time where direct steam is applied and mixing continues during heating. Surprisingly, the analyses show that the feed stability is increased (Figure 2), even though the particle size is also markedly increased (Figure 1) and the viscosity shows an unexplainable peak after 5 minutes where after it decreases again to a low level (Figure 3).

Table 1: Dry matter content of the cheese feeds (average values ± one standard deviation).

	Standard w ES	Standard wo ES	Temp adjust wo ES	Time adjust wo ES	Speed adjust wo ES
Dry matter (%)	36.5 ± 1.9	35.2 ± 1.1	36.4 ± 1.7	31.7 ± 1.0	33.2 ± 0.7

w/wo: with/without; ES: emulsifying salt

A decrease in dry matter content may also improve the stability, and therefore, this may have influenced the relatively good stability of the feed prepared without ES and increased mixing time, where dry matter is relatively low (Table 1). However, the dry matter content of the feed without ES prepared by increasing mixing speed is low as well, and the stability of this feed is low.

Conclusion

The results indicate that changing the processing parameters during production of cheese feed for cheese powder production influence the stability of the feed. Especially prolongation of the mixing time before heating seems to improve the stability of cheese feed without emulsifying salt added.

Materials and methods

Cheese feeds were prepared in pilot plant scale in a Stephan Cooker (Stephan UMC5 electronic, Stephan u. Söhne GmbH) by mixing cheddar cheese (300 g), soft white cheese (200 g) and water (230 g). Cheeses were cut into smaller pieces and transferred to the Stephan cooker along with the water. Before heating mechanical treatment was performed by mixing. Heating was performed by adding direct steam while continuously mixing.

Processing parameters varied:

- mixing speed (1500 or 2100 rpm for 60 s)
- mixing time before heating (60 or 300 s) and
- heating time (45 or 90 s, leading to final temperatures of 79±5°C and 95±1°C, respectively).

The combined low levels of all processing parameters is referred to as the standard. As control sample, a standard feed prepared using the same composition and the low level of all processing parameters, but with the addition of disodium hydrogen phosphate (15 g/kg feed), was used.

All cheese feeds were prepared in duplicate.

All cheese feeds were analysed for dry matter content, particle size (Mastersizer, Malvern Instruments Ltd.), stability by centrifugation at 40°C, and apparent shear viscosity at 60 °C during 45 minutes with shear rate 15 s^{-1} (AR-G2, TA Instruments).

Reference

Lee *et al.* (2003). *Lebensm.-Wiss. U.-Technol.* 36, 339-345