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EMULSIFYING SALT AND CHEDDAR CHEESE AGE: FUNCTIONALITY IN CHEESE POWDER PRODUCTION

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Objective

To study how the rheology, stability and microstructure of hot cheese emulsions for cheese powder production are affected by

- Cheddar cheese age
- Presence of emulsifying salt

Introduction

Cheese powders are used in the food industry as natural functional and flavouring ingredients in applications such as biscuits, savoury snacks, bakery products, sauces, dressings, ready meals and processed cheese.

Cheese powder is produced from cheeses, which are mixed with water and emulsifying salts (primarily sodium phosphates) and subsequently melted to form a hot cheese emulsion (cheese feed). The cheese feed is heat treated and finally spray dried.

Currently there is an increased focus on reducing additives in food as well as a health based desire to reduce the general intake of sodium and phosphates. A need for production of cheese powder without the use of emulsifying salts has therefore emerged. In order to make this possible, however, more knowledge about the functionality of emulsifying salts in stabilization of cheese feed is needed. Emulsifying salts are added to aid creation of an emulsion that remains stable until spray drying and also to ensure a final powder with good storage quality.

Besides addition of emulsifying salt, the stability of cheese feed may also be affected by the characteristics of the cheeses used, addition of other dairy ingredients and processing parameters.

Results and discussion

Stability

Cheese feed containing emulsifying salt showed no separation during the applied centrifugation analysis, whereas cheese feed prepared without emulsifying salt separated into three phases. Cheddar cheese age did affect stability, the onset of separation was delayed and total separation was slightly lower when the 6 months old cheddar was used, whereas higher levels of separation was observed in all steps of the analysis when the 18 months old cheddar was used (data not shown).

Rheological properties

Cheese feed with and without emulsifying salt exhibited markedly different rheological properties and furthermore, an effect of cheddar cheese age was observed. For cheese feed with emulsifying salt, a shear-thinning behaviour was observed in the flow curves (Figure 1 A). Cheese feed without emulsifying salt showed a nearly Newtonian behaviour (Figure 1B).

The effects of cheddar cheese age are different for cheese feed with and without emulsifying salt (Figure 1), indicating that both the maturation itself and the interplay between the emulsifying salt and the maturation of the cheeses influence the rheological properties of the feed.

Comparing the shear stress values for the cheese feed with and without emulsifying salt reveals a difference of more than one order of magnitude, with the lowest values for the cheese feed without emulsifying salt (Figure 1). The big difference observed in flow behaviour and in measured shear stress indicates that emulsifying salt aid in creating structure in the cheese feed, a structure that develops further during a holding time at high temperature (data not shown). These observations are in accordance with those of Lee *et al.* (2003) made on processed cheese.

Microstructure

The CLSM images reveal that cheese feed produced **with** emulsifying salt contain a large number of widely distributed fat particles of varying size (Figure 2 A,C). The protein forms a continuous and compact network. The fat globules appear embedded in the protein matrix with protein adsorbed onto the fat globule surface, indicating that the fat has been emulsified. Increasing cheese age seems to produce cheese feed with a larger fat globule size, indicating that the fat is less emulsified (Figure 2A,C).

In the CLSM images of cheese feed **without** emulsifying salt the protein occur as lumpy non-continuous aggregates (Figure 2 B,D). The fat is less associated with the protein matrix and the fat globules are located in the serum phase. This indicates risk of sedimentation of protein particles and formation of free fat. Increasing cheese age appear to produce cheese feed with smaller protein aggregate sizes (Figure 2 B,D).

Materials and methods

Cheese feed was prepared in a Stephan Cooker (Stephan UMC5 electronic, Stephan u. Söhne GmbH) by mixing cheddar cheese (age 1, 6, 12, or 18 months; 300 g), soft white cheese (200 g), and water (140/160 g, without/with emulsifying salt). All kinds of cheese feed were prepared both with and without emulsifying salt (disodium hydrogen phosphate equivalent to 15 g/kg feed). Cheese feed without emulsifying salt were added potassium hydroxide for pH adjustment. The ingredients were mixed in the Stephan cooker at 1500 rpm for 5 minutes and heated by applying direct steam for 45 seconds under continuous mixing.

All kinds of cheese feed were prepared at least in duplicate. The feed pH value was 5.74 ± 0.03 .

Stability of the cheese feeds was analysed by centrifugation for 5×1 minute at 1500 rpm at 40°C (SL 16R, Thermo Scientific, Karlsruhe, Germany).

Reference

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

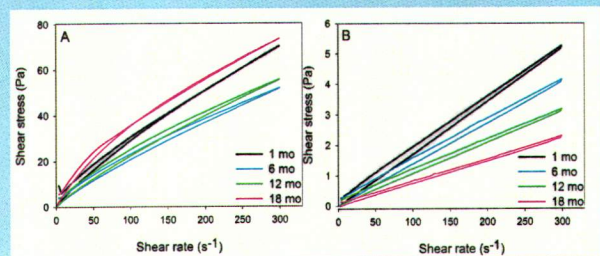


Figure 1: Flow curves for cheese feed produced from cheddar cheeses of different ages with and without emulsifying salt measured approx. 15 min after production.
A: Cheese feeds with emulsifying salt. B: Cheese feeds without emulsifying salt.

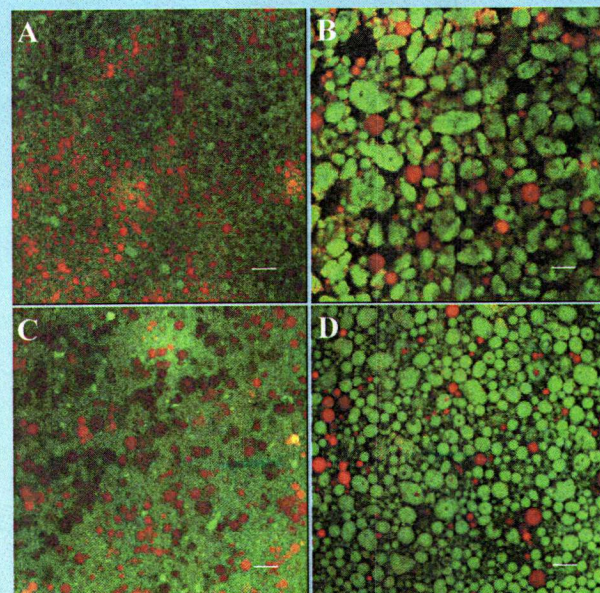


Figure 2: CLSM micrographs of cheese feeds produced from 1 and 18 months cheddar cheeses with, and without emulsifying salt. Green indicates protein, red indicates fat.
A: 1 month with emulsifying salt. B: 1 month without emulsifying salt. C: 18 months with emulsifying salt. D: 18 months without emulsifying salt. Scale bar, 20 µm.

Conclusion

Not including emulsifying salt in cheese feeds for cheese powder production prepared from cheddar cheeses of different ages combined with soft white cheese led to a decrease in the stability and marked changes in the rheological properties of the cheese feeds. Cheese feed without added emulsifying salt lacked the ability to build internal structure, which may be necessary in order to obtain stability. Cheddar cheese age affected the properties of cheese feeds differently with and without emulsifying salt added.

The **rheological properties** of the cheese feeds at 60°C were analysed using a Haake RS 600 rheometer (Thermo Scientific, Karlsruhe, Germany). Each measurement consisted of a flow curve (taken approx. 15 min after production) using shear rates (up and down sweep) ranging from 1 s^{-1} to 300 s^{-1} .

The **microstructure** of the cheese feeds was visualized using confocal laser scanning microscopy (CLSM) (Inverted Point Scanning Confocal SP5 II, Leica Microsystems, Germany) after staining the fat with Nile red and the protein with FITC.