Microstructure and Texture of UF-Feta Cheese

Helle Wium

Department of Dairy and Food Science, The Royal Veterinary and Agricultural University, Rolighedsvej 30, DK-1958 Frederiksberg C, Denmark

ABSTRACT

That it is the mutual position of individual structural elements (protein and eventually fat) that determines the cheese texture is investigated for Feta cheese produced from ultrafiltered milk (UF-Feta cheese) made with constant gross chemical composition. The relation between microstructure and texture of UF-Feta cheese is investigated.

INTRODUCTION

Feta cheese produced from ultrafiltered milk (UF-Feta) has through decades been the most produced cheese in Denmark and the most produced UF-cheese in the world. Texture is an important quality parameter of Feta cheese. By varying the amount of rennet added during the cheese production, UF-Feta cheese differing in texture and with a constant gross chemical composition can be produced. Why is it that an increasing rennet concentration cause the firmness of the UF-Feta cheese to increase? A hypothesis exists that it is the mutual position of the individual structural elements (protein and eventually fat) of UF-Feta cheese that determines the texture of the cheese, when the gross chemical composition of the cheese is constant.

This work presents rheological measurement (uniaxial compression) and information quantified from transmission electron micrographs (TEM) of the protein network of UF-Feta cheese varying greatly in texture produced with various rennet concentrations. The purpose of the study is to investigate the relation between the microstructure and the texture of the cheese. Multivariate statistic is used in the evaluation of the results.

MATERIALS

Four different cheeses were made from the same retentate. The rennet concentration of the UF-Feta cheeses was varied by a factor 36. Rennet-free cheese was also produced. The coagulation procedure is shown in Fig. 1.

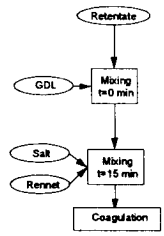

Figure 1. Coagulation of UF-Feta cheese.

METHODS

TEM and image analysis

1 mm^3 cheese cubes were fixed in glutaraldehyde and osmium tetroxide, dehydrated in an ethanol series, embedded in Epon, sectioned, rinsed in periodic acid, and stained with uranyl acetate and lead citrate (26.4 g/l) before examination in a Philips CM100 TEM. Ten micrographs (× 6.610) were systematically taken of each cheese. The micrographs were digitized, segmentation was done at constant volume content (26.4%),and an opening removed the smallest irrelevant objects (< 5 pixels). The global estimated features were: A_A: the area fraction - equals the volume fraction; S_V: the specific surface area $S_V = 2 \times P_L$; and L_3: the mean intercept length. The local estimated features were: the area, the diameter, the roundness, the number of clusters and the perimeter of the objects present in each of the micrograph. The star volumes of the black and the white phase of the TEM micrographs were determined. Skeletonization was done, the network structure was further segmented into part of the skeletonized network containing the end part, the node part and the branch respectively. The number of ends per area, the number of nodes per area, the number of branches per area, and the branch length was found.

Uniaxial compression

Cylindrical samples with height 20 mm and diameter 15.3 mm were conditioned at 15°C. Lubricated compression was done (Instron 5564 Universal Testing Machine, Instron Ltd., High Wycombe, Great Britain) at a deformation rate of 1000 mm/min to 50% of the original sample height. An apparent fracture point was defined as the local maximum of the stress (σ) - Hencky strain (ε_H) curve. Four rheological parameters were extracted from the σ - ε_H curve, as illustrated in Fig. 2.

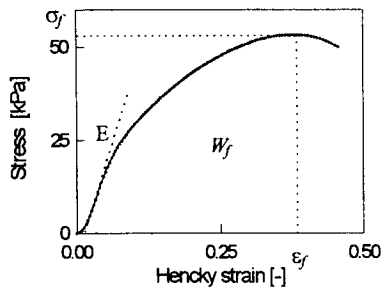

Figure 2. Parameters in uniaxial compression.

RESULTS AND DISCUSSION

Cheeses varying greatly in texture and having the same gross chemical composition (pH, moisture, fat, nitrogen, and NaCl content) were produced. It was possible to quantify the protein network of UF-Feta cheese from TEM micrographs. The microstructural and rheological parameters depended significantly on the rennet concentration used. For instance with a high amount of rennet, where the cheese was evaluated firm and gritty, the size of the protein aggregates increased, the protein network was coarser, whereby the average length of the branches of the protein network increased and the number of nodes per area decreased. The deformability modulus and the strain at fracture measured in uniaxial compression were found correlating with the length of the branches of the protein network.

In conclusion, it seemed that the level of rennet addition, had an effect on the structure of the casein aggregates, which influenced the texture of the final UF-Feta cheese. Lowering the amount of rennet gives a potential for making soft variants of UF-Feta cheese with a smooth texture.