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The Ability of Rheological Methods to Discriminate Between Different Types of UF-Feta Texture

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ABSTRACT

Rheological characteristics of Feta cheeses with different textures produced from ultra-filtered milk (UF-Feta cheese) were evaluated with uniaxial compression and dynamic testing. The ability of these rheological methods to discriminate between three types of texture was investigated.

INTRODUCTION

Texture is very important for consumers perception of cheese quality. Today many different rheological techniques exist. In spite of this only little knowledge is available on how to do rheological measurements so that they reflect results from sensory texture analysis as well as possible.

Uniaxial compression, which is a standard technique for rheological testing on cheese (Luyten[1], Walstra and van Vliet[2]) gives information about the mechanical and fracture properties of cheese at large scale deformation. This information is relevant for comparison with data from sensory texture analysis, where the cheese is degraded during mastication.

Up to now very little dynamic testing has been done on cheese. With dynamic testing the elastic and viscous components of 'firmness' can be quantified in well defined physical units. Deformations during measurements are keept so small that results can be related to types of bonds and microstructure in the intact cheese.

MATERIALS AND METHODS

Materials

Three UF-Feta cheeses with different textures were purchased from Danish dairy plants and stored at 5°C. The sensoric texture attributes of the cheeses is described in Table 1. Plates of cheese were trimmed with a streched wire, and cylindric cheese samples were cut with a lubricated cylindric borer.

Table 1. The sensoric texture attributes of the three Feta cheeses investigated.

Sensory quality	Tin Feta (**T**)	Red brick-type Feta (**RB**)	Blue brick-type Feta (**BB**)
Firmness	Firm	Soft	Softest
Gel-like	Short	Gel-like	Gel-like
Stickiness	Dry	Dry	Sticky
Ability to cut	Easy to cut	Easy to cut	Hard to cut
Ability to spread	Hard to spread	Easy to spread	Easy to spread

Uniaxial constant speed compression

For the compression measurements cylindrical samples with height 15.3 mm and diameter 15.3 mm were used. An Instron UTM 4301 with software Series 9 version 5.22 was used. 1 kN loadcell was used. The samples were conditioned at 13°C for 1½ h before testing. The upper and lower plate were lubricated before compression with a low viscosity oil. Six repetitions were done. Force-displacement data were recalculated into stress (corrected for the actual cross sectional area during the compression assuming cylindrical deformation) and Hencky strain (ε_{Hencky}):

$$\varepsilon_{Hencky} = \left| \ln\left(\frac{H_t}{H_0}\right) \right|$$

H_0 - sample height before deformation, H_t - sample height at time t.

The cross-head speeds used were 100, 200, 300 and 400 mm/min corresponding to initial Hencky strain rates of 0.11, 0.22, 0.33 and 0.44 s^{-1}. From the Stress-Hencky strain curve two variables were defined: Stress at yield point and Hencky strain at yield point (Figure 1).

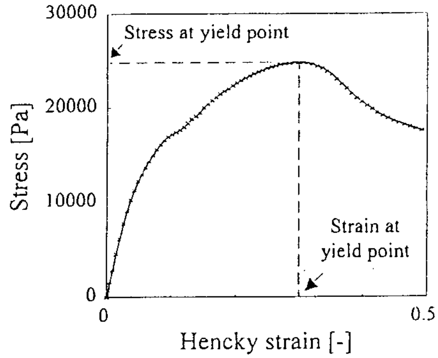

Figure 1. Definition of Stress at yield point and Hencky strain at yield point.

Dynamic shear measurements

For the dynamic shear measurements cylindrical samples with height 4.0 mm and diameter 30.0 mm were used. The samples were conditioned at the measuring temperature 13°C for at least 16 h before testing. The dynamic shear testing was performed on a Bohlin VOR Rheometer. Temperature control was achieved by a Bohlin lower-plate temperature control unit, and by an insulation jacket surrounding the upper plate. Specimens were placed between two serrated, parallel plates (diameter 30 mm). The gap between the serrated plate measuring system (SP30) was set to 3.80 mm. After loading into the system, the cheese sample relaxed for 5 min, torque was reset and the test was performed. Instrumental control and primary data processing were done on a PC with the Bohlin Rheometer Software version 4.05. Five repetitions were done on each of two days.

Strain sweep: The amplitude was varied from 0.5 to 45.0 % in 30 steps with equal distance on a logarithmic scale, frequency was 0.15 Hz and torque element used was either 8.89 or 16.7 mNm, depending on the type of UF-Feta cheese.

Frequency sweep: The frequency was varied from 0.009 to 7 Hz in 8 steps with equal distance on a logarithmic scale, and the amplitude was 0.9 %. Torque element used was 16.7 mNm. Other instrumental settings: Continuous oscillation: off, Autostrain: off.

On all the presented figures error bars are illustrating 95% confidence limits.

RESULTS

Uniaxial constant speed compression

In Figure 2a and b the Stress at yield point and Hencky strain at yield point is shown as a function of initial Hencky strain rate. Stress at yield point was able to distinguish the three Feta textures at all measured initial Hencky strain rates.

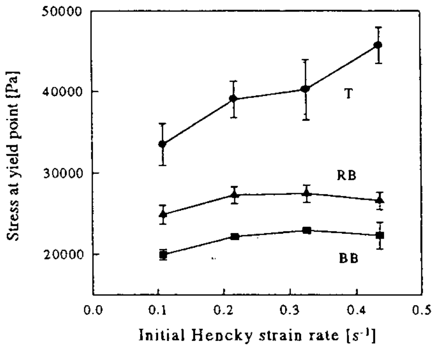

Figure 2a. Stress at yield point.

Hencky strain at yield point was able to distinguish the Tin Feta cheese texture from the two brick type Feta cheese textures at all measured initial Hencky strain rates.

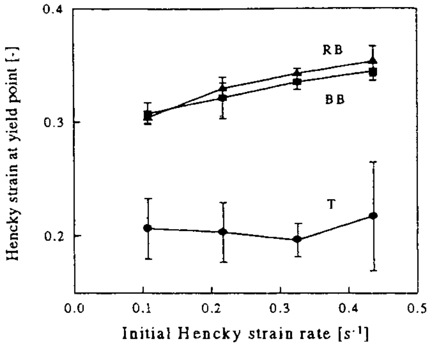

Figure 2b. Hencky strain at yield point.

Strain sweep

Log G^* was able to distinguish the Tin Feta cheese texture (T) from the two brick type cheese textures at all measured strain values (Figure 3a), and δ was able to distinguish the Red Brick type Feta cheese (RB) from the Blue Brick type Feta cheese (BB) at strain values higher than $3*10^{-4}$ (Figure 3b).

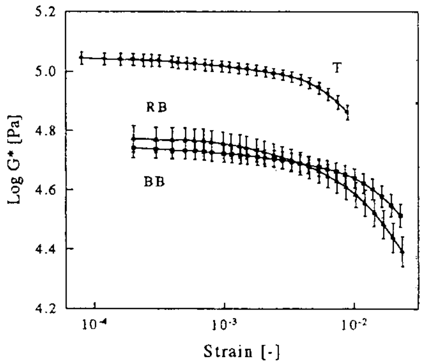

Figure 3a. Strain sweep of the logarithm of the complex modulus.

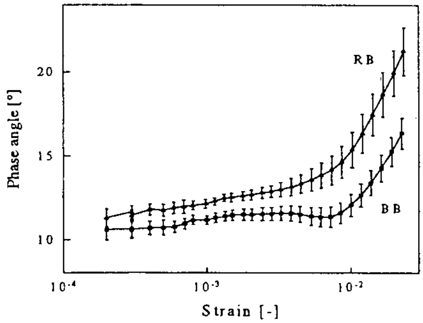

Figure 3b. Strain sweep of phase angle.

Frequency sweep

Log G^* was able to distinguish the Tin Feta cheese texture from the brick type Feta cheese textures at all frequencies (Figure 4).

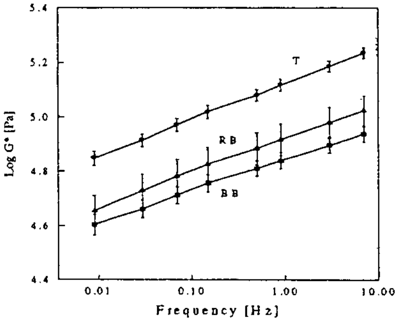

Figure 4. Frequency sweep of the logatrithm of the complex modulus.

CONCLUSIONS

Stress at yield point was able to distinguish all three investigated Feta textures at any initial strain rate investigated (0.11 - 0.44 s^{-1}). Strain at yield point could discriminate the Tin Feta cheese texture from the two brick type Feta cheese textures. The phase angle measured in a strain sweep was able to differentiate the Blue brick type Feta cheese texture from the Red brick type Feta cheese texture in the strain interval 0.0003-0.024. The complex modulus from the strain and frequency sweeps were able to distinguish the Tin Feta cheese texture from the brick type Feta cheese textures at measured strain (0.00008-0.024) and frequency (0.009-7 Hz) values.

REFERENCES

1. H. Luyten, The rheological and fracture properties of Gouda cheese, Ph.D.-thesis, Laboratory of Dairying and Food Physics, Department of Food Science, Wageningen Agricultural University, 1988.

2. P. Walstra, T. van Vliet (eds.), Rheological and fracture properties of cheese. Bulletin of the International Dairy Federation N° 268, 1991.