Comparison of a Sliced Cheese with a Vegan Alternative

Annika Hodapp and Klaus Oldörp

Thermo Fisher Scientific, D-76185 Karlsruhe, Germany

ABSTRACT

The texture is an important part of a cheese's properties. Depending on the kind of cheese and its age this can range from creamy to solid. Rheological measurements can be used to quantify the viscoelastic properties of cheese and cheese formulations. On top of that, a modern rheometer is equipped with a normal force sensor and therefore offers capabilities beyond the classic rheological measurements. In combination with its automatic lift, a rheometer can also be used to run texture analysis tests. In case of a cheese this could be used to quantify e.g., its bite or its cutting properties.

MATERIALS AND METHODS

For the measurements described here, a sliced butter cheese and a sliced vegan alternative were used. The milk-based cheese consisted mainly of protein and fat (25 % and 24 % respectively). The main components of the vegan alternative were fat and starch (20 % and 17 % respectively) while its protein content was below 1 %.

To get a general idea about the properties of both products, amplitude sweeps at 20 °C and 37 °C were performed over a strain range from 0.01 % and 100 % at a frequency of 1 Hz. The end of the linear-viscoelastic range (LVR) was calculated based on the storage modulus G' using a 10 % deviation from the plateau value. The measurements at 20 °C were intended to show the sample properties at room temperature, where cheese is cut or a piece is bitten off, for example. At 37 °C the behaviour during chewing or swallowing was investigated.

The temperature-dependent behaviour of both products was examined between 5 °C and 90 °C. During the measurement, the rheometer applied a constant oscillation with 1 % strain and 1 Hz to the sample while the temperature was increased with a heating rate of 2 K/min.

Finally, the cutting or biting resistance of both products was tested by running penetration tests with a 4-bladed vane rotor of 22 mm diameter at 20 °C. Discs of 35 mm diameter was placed onto the lower plate. The vane rotor was moved downwards to a position of 5 mm above the lower plate and the sample was left to rest for 10 min to adapt to the temperature. Afterwards the vane rotor was moved downwards with 0.1 mm/s. The position at which the surface of the sample was detected by an axial force of 0.1 N was set as the starting point for the relative gap Δh. The vane rotor continued to move into the sample with 0.1 mm/s until it almost touched the lower plate.

RESULTS

At 20 °C, the end of the LVR for vegan and milk-based product was calculated at 0.6 % and 0.7 % deformation respectively (see **Fig. 1**). A look at the corresponding shear stress values is much more informative. The end of the LVR for the vegan product is at 441 Pa while it is at 929 Pa for the milk-based product.

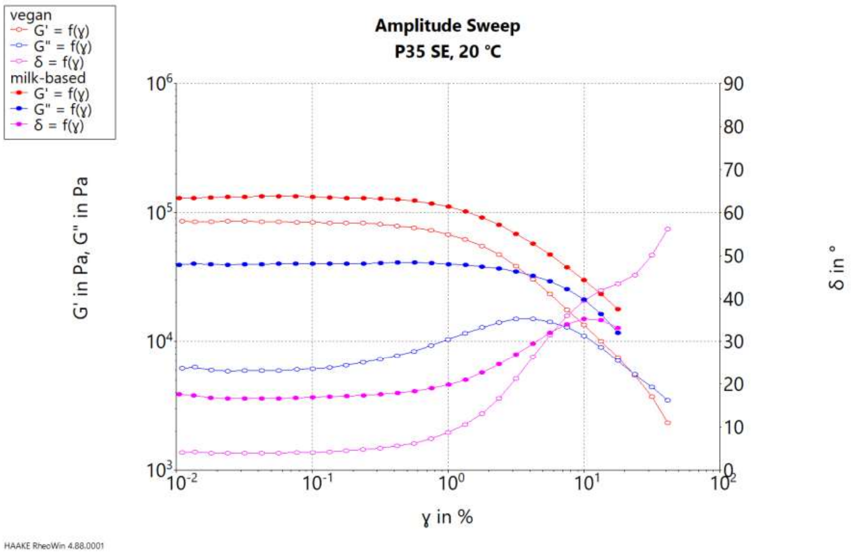

FIGURE 1: Amplitude sweeps at 20 °C

Below 0.1 % deformation, the vegan product shows a plateau value of δ = 4.0 ° while the milk-based product shows a value of 17 °. Towards higher deformations, the vegan product shows a steeper increase of δ exceeding the δ-values of the milk-based cheese above 6 % of deformation.

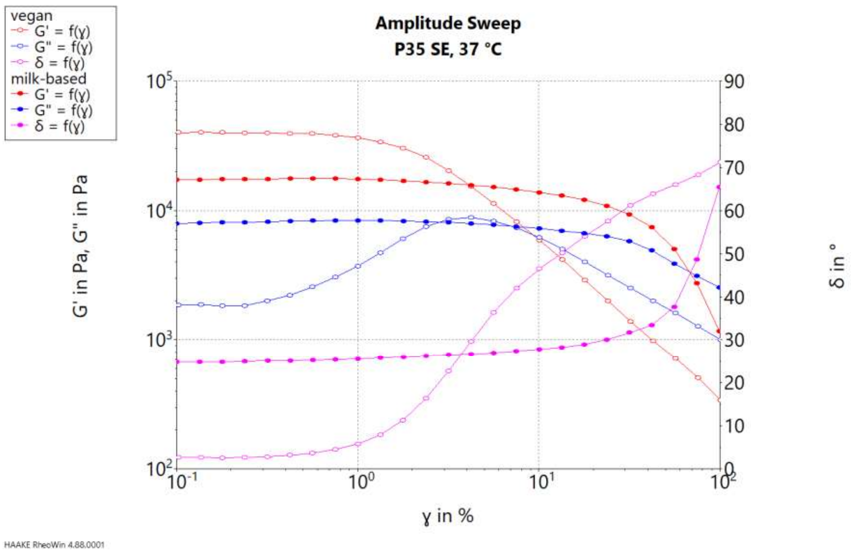

FIGURE 2: Amplitude sweeps at 37 °C

Going from 20 °C to 37 °C reveals a major difference between both products. While the milk-based cheese softens due to the higher temperature ($\delta_{Plateau}$ = 24.8 °), the vegan product becomes more elastic ($\delta_{Plateau}$ = 2.1 °) (see **Fig. 2**).

The end of LVR also shows this difference between the vegan and the milk-based product with a deformation of 1.1 % and 5.3 % respectively while the corresponding stress values almost stayed the same.
The results of the temperature sweeps show the behaviour of the two products over a wider temperature range. At “fridge temperature” of +5 °C, the milk-based cheese had a viscosity of 27000 Pas. With increasing temperature, its viscosity dropped continuously to 45 Pas at +90 °C (**Fig.** 3). The vegan product showed a more complex viscosity curve. It started with about half the viscosity of the milk-based cheese at +5 °C but showed a much smaller decrease in viscosity up to +55 °C. Above +23 °C its viscosity was higher than that of the milk-based product and ended with 100 Pas at +90 °C.

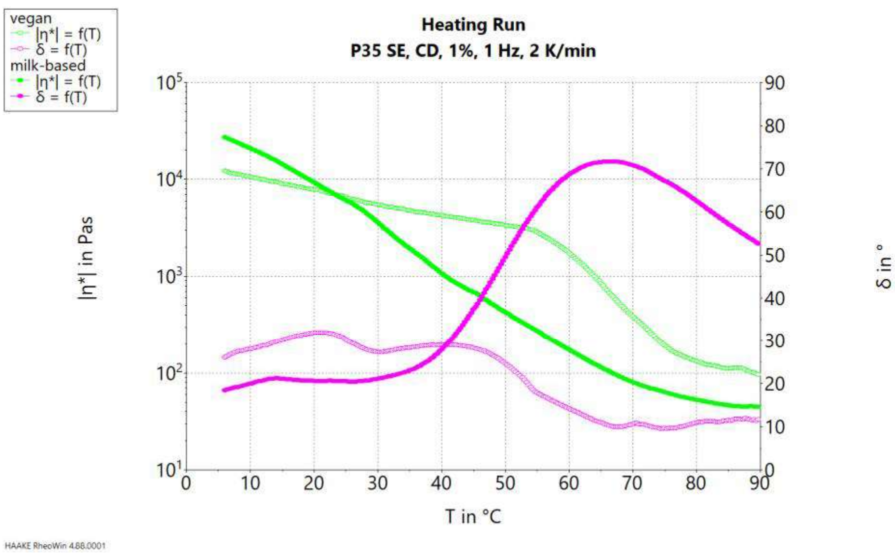

FIGURE 3: Viscosity and phase angle 90 °C

The much more significant difference of both products showed in the change of δ above +27 °C. The δ-values of the milk-based product increased, showed a melting point (δ = 45 °) at +48 °C and stayed above 50 ° until the end of the measurement. In contrast, the δ-values of the vegan product remained almost constant above +27 °C until they started to decrease above +42 °C down to 10 °. With further increase of temperature, δ slightly increased and reached 12 ° at +90 °C. The vegan product did not show a melting point.

The penetration tests have been repeated 3 times on both samples. Keeping in mind that cheese samples are never exactly identical the results show a very satisfying reproducibility. Although the rheological tests showed that the vegan product has a higher elasticity and a stronger resistance against compression, its cut resistance was significantly lower than that of the milk-based cheese (see **Fig.** 4).

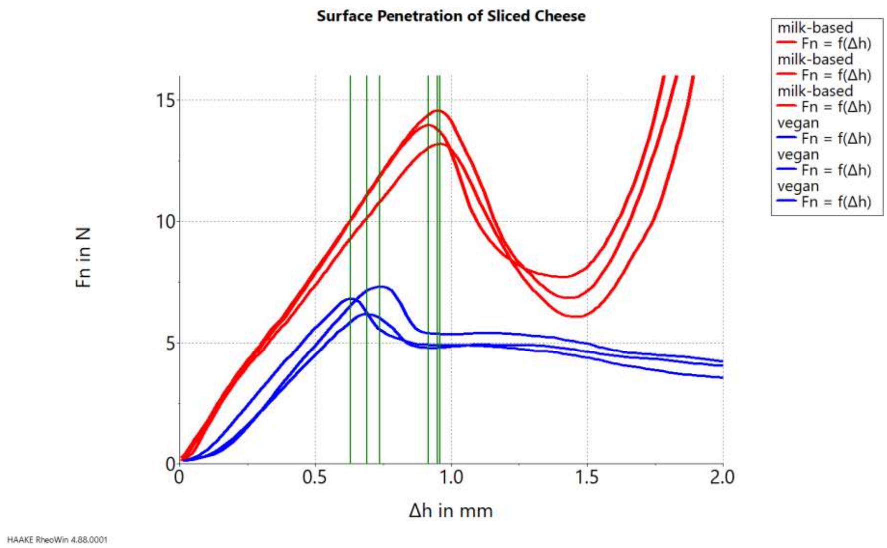

FIGURE 4: Penetration tests

After 0.69 mm and at a force of 6.8 N the blades of the vane rotor cut into the vegan slice. The milk-based cheese was a bit more flexible and a lot more stable. After 0.94 mm and at a force of 13.9 N its surface was cut. The second increase in force is due to the rotor touching the lower plate since the milk-based cheese slices were slightly less than 1.5 mm thick.

CONCLUSIONS

The vegan product showed a higher elasticity but less stability, which can be noticed when cutting or biting into it. Its behaviour during a temperature sweep was fundamentally different from that of the milk-based cheese. Although the selection of the two products compared was arbitrary, the results show general differences between fat/protein-based products and their starch/fat-based substitutes.