Large amplitude oscillatory shear and sensory profiling of Peanut butter and Tahin

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ABSTRACT

Large amplitude oscillatory shear (LAOS) and sensory profiling were used as tools for characterising the quality of Peanut butter and Tahin. Seven different products were evaluated and a correlation between sensory and LAOS data at high strains were found.

INTRODUCTION

The natural variation of food ingredients can have large influence on the final product, which is the case for Peanut butter and Tahin produced by Urtekram International A/S. The natural variation of peanuts and sesame seed include amongst other differences in oil content. In addition to the natural variation of ingredients, process variation such as different roasting or grinding degree contribute too to product variation. In order to be able to control the above-mentioned differences, an internal quality program was setup.

Texture plays a very important role when it comes to consumer acceptance of a product. Sensory evaluation is currently the golden standard for evaluating attributes related to texture[1]. Sensory profiling can in some cases be expensive to carry out and require trained personal. As an alternative for characterising texture, rheology and other physical parameters can be measured.

Traditional rheology methods such as viscosity can though be difficult to measure in products such a Peanut butter and Tahin due to disturbance in the shear rate interval of interest for consumption. Chewing and swallowing are simulated in the interval 10-100 s^{-1}.[1] On the other hand, is non-linear rheology at large stains; 100-1000, expected to be able to simulate the chewing and swallowing process. Large amplitude oscillatory shear (LAOS) data for products provide a fingerprint of the textural properties. These data are expected to correlate to the overall sensory profiling of the product, as the differences between the products are expected mainly to be due to textural differences. Due to the nature of the products particle size is also chosen as an interesting physical parameter to test.

The overall goal of the work performed is twofold. First, find correlations between sensory profiling and physical data. Second, develop a quality program for internal use in Urtekram International A/S in the production of Peanut butter and Tahin.

MATERIALS AND METHODS

Products

1 Peanut butter smooth, 3 Peanut butter crunch and 3 Tahin produced by Urtekram International A/S.

Viscosity

The viscosity of the Peanut butter crunch products was measured from 1-100 s^{-1} at 22^0C using a vane geometry due to the nature

of the products. The viscosity was measured using a rheometer (Anton Paar).

Large amplitude oscillatory shear

Large amplitude oscillatory shear was measured on all products at 1 Hz in the shear strain interval 0.01-1000% with a vane geometry using a rheometer (Anton Paar).

Particle size distribution

Particle size distribution was measured on all samples from 0.2 µm to 2 mm using a Mastersizer (Malvern Instruments). Particles larger than 2 mm was filtered out before the measurement of the three peanut butter crunch products.

Sensory profiling

Sensory profiling was performed on all products and obtained using an accredited panel of judges and quantitative data analysis were performed on the data.

RESULTS AND DISCUSSION

Peanut butter

The viscosity of the Peanut butter crunch products was as expected difficult to measure in the shear rate interval of interest for simulating chewing, 10-100 s^{-1} due to disturbance in the data measurements, which increased with increasing shear rate. This can be observed in Figure 1 and the shear rate interval interesting for chewing and swallowing are circled.

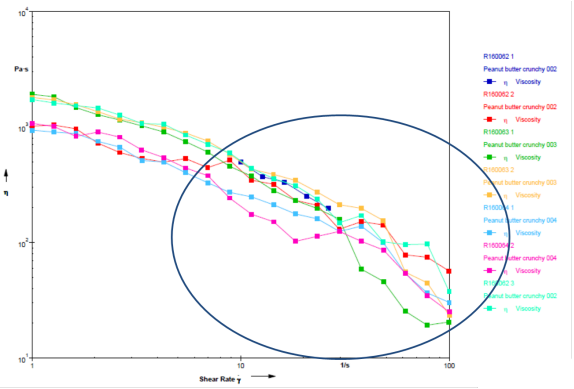

Figure 1. Viscosity of Peanut butter crunch 1, 2 and 3 from 1-100 s^{-1}.

From the data showed in Figure 1 it is though still possible to calculate the viscosity at the lowest desired shear rates (10 s^{-1}). The results are shown in Table 1 and indicates that Peanut butter crunch 3 differs from Peanut butter crunch 1 and 2.

Table 1. Viscosity at 10 s^{-1}.

Products	Viscosity (Pa·s)
PB crunch 1	475 ± 32
PB crunch 2	461 ± 49
PB crunch 3	237 ± 24

Large amplitude oscillatory shear data are measured in the shear strain interval from 0.01-1000%. Lissajous curves are plotted for 1, 10, 100 and 1000% strain, which is outside of the linear viscoelastic region. The four stains are marked in Figure 2 that shows the LAOS data for a Peanut butter.

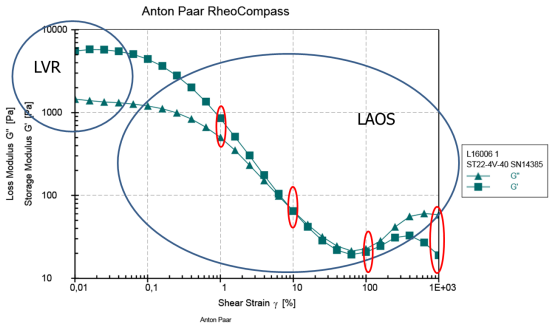

Figure 2. Large amplitude oscillatory shear data showing the strains chosen for plotting Lissajous curves.

The Lissajous curves in Figure 3 shows as expected that the products behave different at the different strains. The shape of the curves indicate if the product behaves elastic, viscoelastic or viscous. Going toward higher strains the Lissajous curves of the products become more circular, which indicates that the product goes from viscoselastic behaviour toward more viscous behaviour [3]. Going toward a liquid behaviour is expected with increasing strain. From Figure 3 it can be observed that Peanut butter crunch 2 and 3 are more alike

at the lower strains (1 and 10%). Whilst at higher strains (100 and 1000%), where the products starts to flow more, Peanut butter crunch 1 and 2 are more similar, which corresponds to the viscosity measurements shown in Table 1.

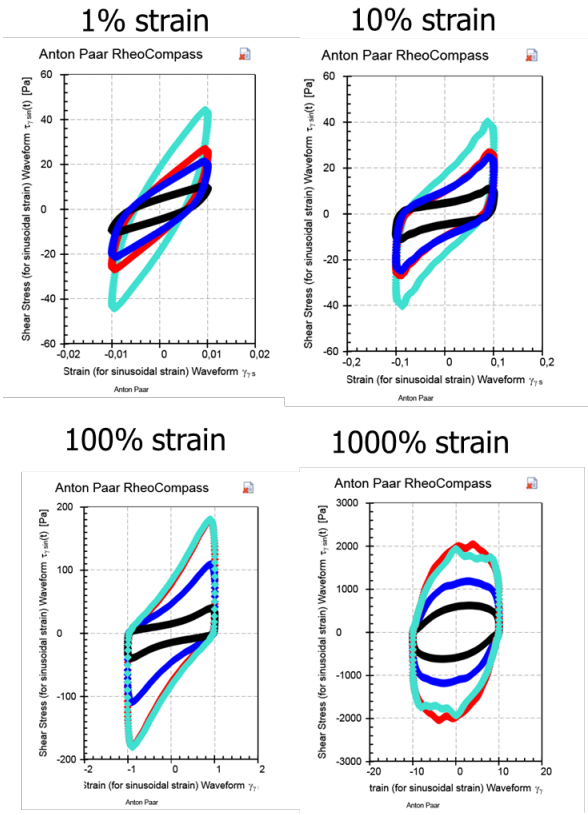

Figure 3. Lissajous curves at 1, 10, 100 and 1000% strain. Black curve show Peanut butter smooth, light grey are Peanut butter crunch 1, dark grey are Peanut butter 2, light black curve are Peanut butter 3.

The particle size distribution after filtering out the particles larger than 2 mm are shown in Table 2. Based on the particles smaller than 2 mm product 2 and 3 are more similar, which were also the case for the LAOS data at lower strains.

Table 2. Particle size distribution.

Products	D(0.1)	D(0.5)	D(0.9)
PB smooth	2,1	14,0	46,2
PB crunch 1	2.2	14,6	50.3
PB crunch 2	2.5	16,3	58,2
PB crunch 3	2.5	16,0	56,5

The set of words chosen for the sensory profiling was based on the sensory properties of the product. The profiled areas include appearance, smell, texture, taste, mouth feeling and after taste. The result showed that Peanut butter crunch 1 and 2 are more mutual comparable. The profiling showed that Peanut butter crunch are coupled with word like firmness, coarseness and pieces of nuts. Peanut butter smooth is coupled with word like peanut and oiled.

Tahin

The Lissajous curves in Figure 4 shows as was the case for the Peanut butter products that the products go towards are a more fluid behavior at larger strains. From the figure it can furthermore be observed thatTahin 2 stands out from Tahin 1 and 3.

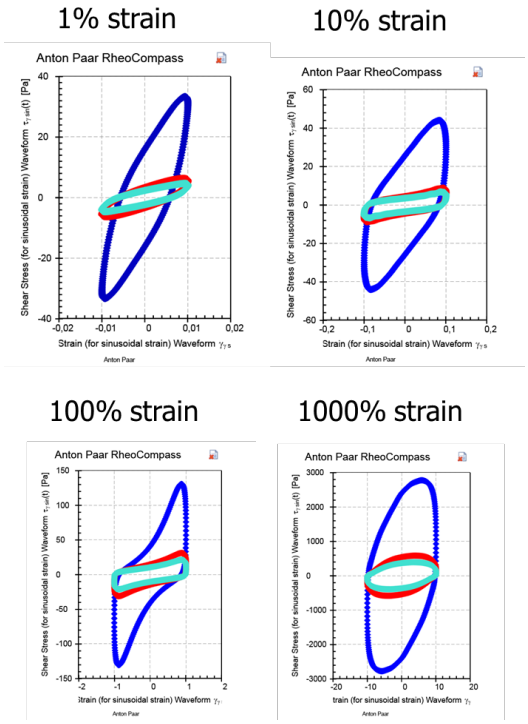

Figure 4. Lissajous curves at 1, 10, 100 and 1000% strain. Black curve show Tahin 2, light grey Tahin 1 and dark grey Tahin 3.

The particle size distribution are shown in Table 3. It is again very clear that Tahin 2

stands out and based on the particle 1 and 3 are very similar.

Table 3. Particle size distribution

Products	D(0.1)	D(0.5)	D(0.9)
Tahin 1	1.7	14,2	315
Tahin 2	1.8	18,7	540
Tahin 3	1.7	15,0	218

The sensory profiling showed that Tahin 1 and 3 are more comparable and coupled with words like sticky, fluently and dryness. Tahin 2 stand out and are coupled with words like burnt, salty, roasted, sesame and grainy.

Correlation between physical analysis and sensory data

The physical and sensory data are correlated in a PCA plot shown in Figure 6.

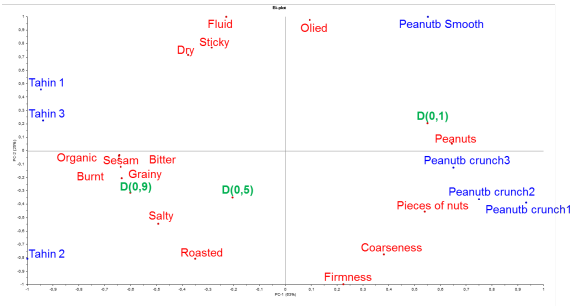

Figure 6. PCA plot of sensory and physical data.

From the plot in Figure 6 it can be observed that Peanut butter crunch 1 and 2 are more alike and closer related to the word firmness than Peanut Butter 3. Peanut butter smooth are more related to oiled and further away from the word firmness. The large difference between Tahin 2 and the other two Tahins can be observed. It can furthermore, be observed that two Tahins 1 and 3 differ some even though they are quite similar compared to Tahin 2.

CONCLUSIONS

The texture of Peanut butter and Tahin described through sensory profiling can be correlated to LAOS data at higher strains, 100 and 1000%. LAOS data can furthermore be correlated to viscosity data. Viscosity measurements would be too unsecure a method to use for quality testing as there is great disturbance in the measurements at the relevant shear rates. It can be concluded that LAOS measurements and sensory profiling both provide the data desired for an internal quality program regarding texture. Sensory profiling can furthermore, include the results of the processing parameters such as roasting notes, which are of special importance for Tahin.

REFERENCES

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