Rheological methods for characterization of industrially produced jam

Marie Skov Pedersen[1,3], Kristian Hovde Liland[2], Tove Devold[1], Elling-Olav Rukke[1], Elin Mittet[3] and Reidar Barfod Schüller[1]

[1] Faculty of Chemistry, Biotechnology and Food Science (KBM), Norwegian University of Life Sciences, P.O.Box 5003, N-1433 Ås, Norway.
[2] Faculty of Science and Technology, Norwegian University of Life Sciences, P.O.Box 5003, N-1433 Ås, Norway.
[3] Orkla, P.O.Box 423 Skøyen, N-0213 Oslo, Norway.

BACKGROUND AND OBJECTIVES

The food industry requires quick and reliable methods for characterization of properties of industrially produced jams. It was of interest to investigate if it was possible to detect significant differences when the type of pectin in the recipe was changed.

Three types of jams have in this study been characterized using several different methods, both using a texture analyser and a rheometer. The method used in the texture analyser was a classical TPA (Texture Profile Analysis)[1, 2] with post-processing using a suitable macro.

The results show that rheological methods reveal many of the important properties of industrial jams. Some of these properties can be linked to sensory perception.

The goal of this work was to investigate which measurement methods that are suitable to characterize the texture and rheological properties of industrial jam. It was also of interest to be able to detect the difference of different pectins or pectin mixtures in the recipes.

The texture in jam depends on several factors like the concentration of berries, sugar and additives[3]. Concentration of pectin and sugar affect the strength of the jam, which is investigated in this report. There are many different pectins on the market and the type of pectin is often chosen to achieve desired product properties and the required texture. A low concentration of pectin may not give the desired texture by not making a gel, while a too high concentration can cause production problems and a non-cohesive jam[4].

The attributes from a parallel sensory study were also made available to increase the number of product properties included in the study. A part of the study was trying to determine which variables are correlated.

MATERIALS AND METHODS

The jams:

Several different jams were produced using different types of fruits to conserve and make good quality pruducts[3, 5, 6]. The recipes used different types of pectin[4, 7, 8].

Sensory analysis

During the sensory evaluation 8 semi-trained panelists were asked to identify the intensity of hardness, elasticity, and coating in mouth on a scale from 1 – 5, where 1 was low/little and 5 high/much. Hardness and elasticity were determined using a spoon, while the coating was analyzed by how much the jam coated the mouth when eating. The results were used to investigate correlations in jam.

Texture analyser setup

A texture profile analysis (TPA)[1, 2] was performed using a texture profiler from Stable Micro Systems Ltd., UK, using data collected from a normal two-bite test procedure. A Delrin 10 mm diameter probe was used, and this was set to penetrate 5 mm into the jam. The test speed during measurements was 2 mm/s.

Rheometer setup

An MCR301 (Anton Paar) rheometer was used in these tests. Several measuring systems were used; a BM 12/72.5 ball measuring system and a normal PP50 plate/plate measuring system.

The ball measuring system was used to determine the viscosity at different shear rates during a full revolution for jams containing fruits or berries.

The plate measuring system was used for all the measurements made on the filtrate, amplitude sweeps, viscosity, and structure build-up.

Statistical analysis

Significant differences between the samples were determined using ANOVA (ANalysis Of VAriance) with the statistical software package R[10].

Correlation matrices were calculated using the statistical software package R.

Correlation coefficients between variables

The data were analysed in RheoPlus and exported to Excel for plotting. The analysis determined the limit of the linear viscoelastic range by running a macro that determined the point where the value of the stiffness, G', was reduced by 3%. The value of the strain and the stress at this point were denoted the strain limit and the strength. The value of stiffness, is the G' value at the start of the amplitude sweep[7].

RESULTS

Texture analyzer results

The texture analyser with the TPA macro generated results for many variables as shown in Fig. 1.

Rheometer results

The ball measuring system successfully measures the viscosity at a range of shear rates. The jams and the filtrates were all shear thinning. Thus, two viscosities and a slope are given for both the ball system results and the plate system results. The first viscosity is at low shear rate, the second viscosity is at the high shear rate, and the slope is descriptive of the downward sloping line between the two points.

The amplitude sweep data, and the LVE macro in RheoPlus, successfully determined the stiffness, the strength, and the strain limit of all the filtrate samples at a 3% reduction in *G'*.

Sensory analysis

Three variables were determined by a sensory panel. These were a hardness, an elasticity, and a variable denoted coating being a measure of how well the jam managed to coat the surfaces in the mouth.

Correlation coefficients

A typical plot of correlation coefficients is shown in Fig. 2. The colour black indicates a coefficient of +1, while white indicates -1. The size of the marker is also proportional to the magnitude of the coefficient.

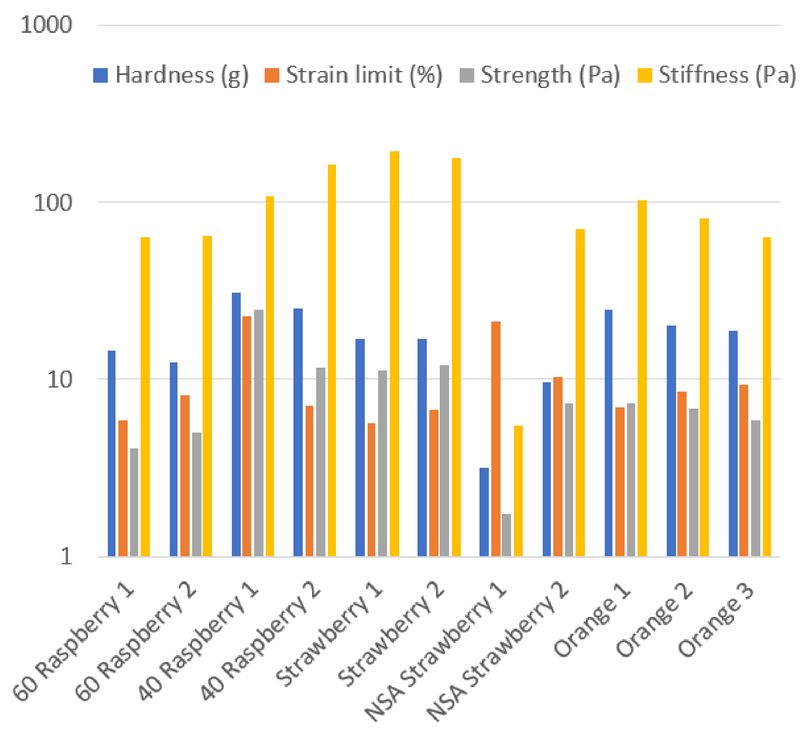

Figure 1. Hardness, Strain limit, Strength and Stiffness of the different jams.

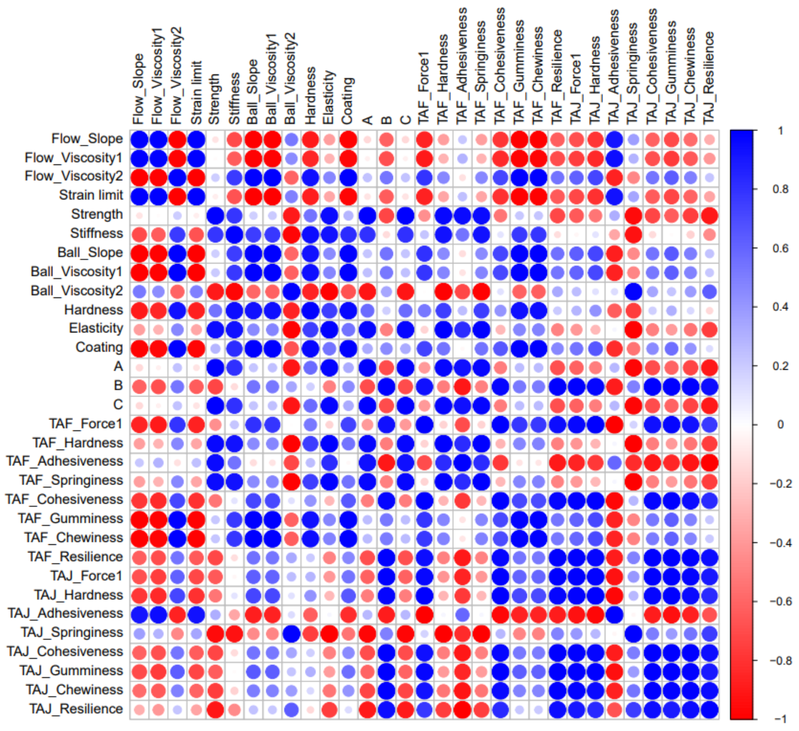

Figure 2. Correlation matrix for the Orange 1 type jam. The values vary from -1 to +1. The size of the marker increases with magnitude, and the colour scale on the right indicates numerical value; blue indicates +1 and red indicates -1.

DISCUSSION

In this study the fresh casein concentrate was used as raw material for Quark production. The motive for this investigation was to look at eventually rheological effects after freezing Quark for 6 months, both as a product by itself and/or as an ingredient in other dishes. Significant differences were observed for all the variables, except fracturability, as this property was only observed in very few samples from the TPA. There was not found any or very few differences between the jams of '60 Raspberry' and the strawberry jams for the different parameters, however there were many differences between '40 Raspberry' and 'Orange'. One of the samples made from strawberry, 'NSA Strawberry 1', did not get the expected texture and did not make a typical gel that was expected. This may explain all the differences between these two jams in all the analysis and variables. The differences found between the jams can be explained by differences in the pectin-types, combinations and concentration, where their degree of methylation and amidation were different[4, 9]. However, the TPA was able to detect differences for some of the jams for all variables.

A similar pattern of significant differences between the jams were found in the viscosity analysis. The filtrates showed differences in stiffness, strength, and the strain limit from the amplitude sweep measurements. It seems like the variables showed largest differences between the '40 Raspberry' and the orange jam. There were also found large differences between each kind of jam, which indicates that the analysis can detect differences in the jam and filtrate.

We observe that there were strong positive correlations between many of the variables, and strong negative correlations between others. There are also variables that seem to have essentially no correlation, shown by the presence of small diameter white colour symbols in Fig. 2.

It was expected to find some correlation patterns that were similar for all the jams. However, this was not seen, and no general conclusions on the interaction between variables could be drawn. If there had been more samples and several more repetitions of the different analyses, the data may have revealed more information and clearer relationships.

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