Rheological Profiles and Fingerprints of Food Products

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ABSTRACT

A new technique to visualise the texture and consistency of food products has been developed. The "rheological profile" or "rheological fingerprint", as it has been named, is based on a representation of rheological values in a spider plot. The strength of the profile is its ability of easy comparison of the texture of two or more food products of the same type.

INTRODUCTION

The texture and consistency of a food product are seldom fully described by the use of a single value. The description most often involves several rheological measurements and often the use of more than one information from each measurement. If a product is characterised by more than a few rheological parameters, it is difficult to form a general view of a group of products by comparing the rheological qualities one by one. Therefore it has been our goal to depict all the parameters for a product in a single plot. In that aspect the plot would represent a rheological profile or a rheological fingerprint of the product.

A rheological profile has a wide variety of uses. The main use will naturally be in comparisons of products. It could be a comparison between a standard profile and profiles routinely recorded from the production. In other words it can be used as a tool in quality control. In product development the rheological fingerprint can be used if there is a knowledge of how the profile should look or if the goal is to duplicate the qualities of another known product.

CHOICE OF VISUALISATION

The first step in developing a rheological fingerprint was to select a way of visualising the data. The main objective was to find a single plot which could include all the rheological parameters needed to characterise the product. With this limitation in mind two types of plots were examined. One was the spider plot which today is used when making sensory profiles. The other was the horizontal bar plot which resembles a method used in Denmark to illustrate nutritional information of some food products. The investigation of the methods concluded that both plots were suitable for the task. Though it was judged, that the spider plot was the most illustrative plot and therefore the overall preference. However, in cases with only four or less parameters the horizontal bar plot might be the best choice. In general it is recommended that the spider plot is used in situations where more than four parameters are present and the bar plot in situations with less parameters.

SCALING METHODS

Rheological values have very different orders of magnitude. In practice a difference in the order of 10^5 in the rheological values of a product is not uncommon. As an example the elastic modules could easily be measured as 10^6 Pa whereas the phase angle in the same experiment will be between 0 and 90°. In order to clearly visualise differences between products that contain rheological values of both large and small values, it is necessary to scale the values before they are used in the rheological profile.

Different methods of scaling have been investigated. Three of these, which are all based on the same principles, can be recommended. Following a scaling the rheological values will most often be ranged between -10 and 10. The principle in the scaling is that an average is subtracted from each of the variables and the new value is then divided by the standard deviation. In the equation x refers to the original value and x' to the scaled value.

$$x' = \frac{x - average}{std.\,deviation}$$

The differences between the three recommended scaling methods is the choice of average and standard deviation as illustrated below.

Method 1

This is a regular standardisation also called a normalisation. Here the average of all products are compared and the standard deviation of the products that are to be compared is used.

Method 2

This is a standardisation with the standard deviation of the analysis. The average of the products is used as in Method 1. The standard deviation used in this method is the deviation of the rheological analysis also called the error of the analysis.

Method 3

This is a scaling relative to a fixed standard. In stead of using the average of the products that are to be compared a fixed value is used. The fixed value can be obtained from a standard product or can be obtained as an average of a group of products. The standard deviation of the analysis is used as in Method 2.

Each method has its own advantages and disadvantages. The choice of method therefore depends on the situation and the character of the information (values).

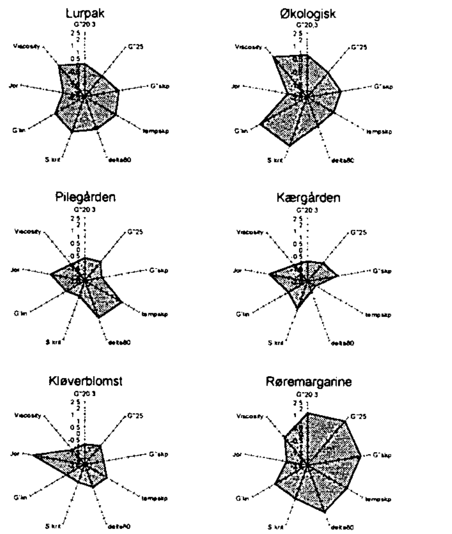

Figure 1. An example of 6 butter products presented according to Method 1.

Method 1 gives a snapshot of the differences in a group of products. The actual snapshot or rheological profile of each of the products depend on the whole group of products. In this method it is important that there is a real difference between the products because the deviation of the products is used as the scaling factor. With these restrictions in mind it is a quick and easy to use method for comparison between a group of products. The method cannot be used with only a single or two products. A whole group is needed and the rheological profiles all depend on which products belong to the group. Therefore the name "rheological profile" will be appropriate in this situation.

Method 2 illustrates where the most important rheological differences between the products are to be found. Thus, it can be seen which are the most pronounced differences and which differences that cannot be regarded as real. It is a precondition that the error of the analysis of each of the rheological values, which are used in the profile, is known. The profiles still depend on the group of products to which they are compared. This is due to the fact that the base value of the profiles is identical to the average values of the group of products. Therefore it is necessary to make new profiles each time a group of products has to be compared. The method therefore cannot be used to make a profile of a single product.

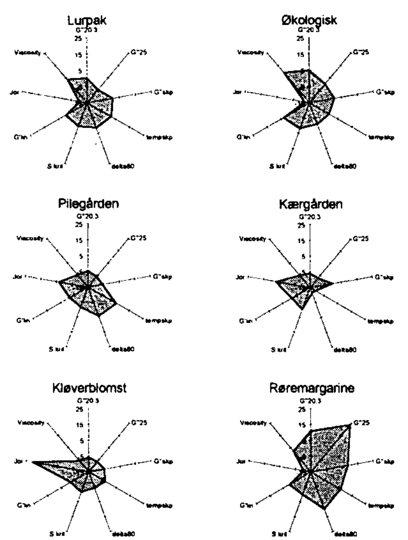

Figure 2. An example of 6 butter products presented according to Method 2.

Method 3 is based on the use of a standard reference. The products are then compared to this standard. The strength of this method is its ability to make profiles of single products. Each time a new product has to be compared to previous products a profile can be made and the comparison take place. By this method it is possible to use the profiles to judge which of the rheological characteristics that contribute with the largest differences and which are not significantly different. The method can be used to make rheological profiles of single products as soon as the standard is defined and the errors of the analysis are known.

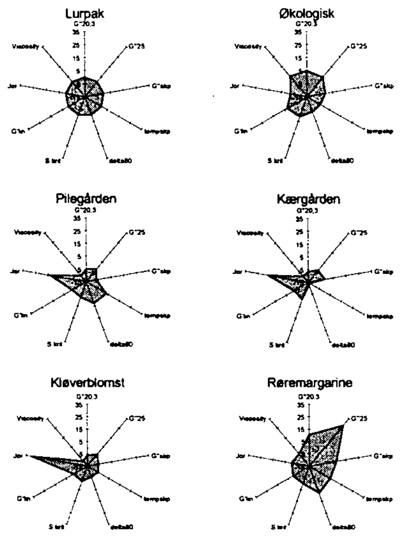

Figure 3. An example of 6 butter products presented according to Method 3.

CONCLUSION

Three methods have been found useful in making rheological profiles. The three methods are all based on the same principle. Though, Method 2 and 3 are recommended in most situations.

The rheological profiles all depend on the reference to which they are compared. In that aspect the profiles will change according to the group of products they are compared to or the product which has been chosen as a reference. This emphasise the importance of knowing the background when using the rheological profiles.

Considering the above restriction, the rheological profiles is a strong tool in visualising rheological characteristics of different products as well as a useful tool in both quality control and product development. If the rheological profiles are coupled with information of how to control each of the rheological characteristics in the plots it would be possible to control both the production and adjust product recipes based on the information in the profiles.

The rheological profile is a well suited tool to enhance better communication of rheological statements to and between people that are not routinely involved in the field