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DETERMINATION OF THE RHEOLOGICAL PROPERTIES OF MAYONNAISE

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ABSTRACT

The instrument for determination the texture with air puff's - Foodtexture Puff Device (FPD) is a new device that yields contactless, fast, easy and non-destructive rheological measurements of food products. The instrument applies a controlled air pulse to the surface of a food product, while a laser distance sensor measures the deformation. This approach can be considered as an alternative method for more fundamental rheological properties like storage and loss module, viscosity, elasticity.

The applicability of FPD for determination the rheological properties of mayonnaise was comparatively evaluated in relation to texture analyzer and rheometer. Eight commercial mayonnaise-type products and three types of lab made mayonnaise were analyzed with the FPD, texture analyzer (spreadability rig) and the rheometer (storage and loss module from a frequency sweep).

All three instruments are tested at three different selected temperatures. The correlation between the results from different instruments was determined.

The FPD was able to determine the emulsion firmness with a low standard deviation and good temperature sensitivity. In addition, it was established that the maximum deformation created by the FPD was strongly correlated to the firmness of the emulsions as determined by texture analyzer, and to the storage module of the frequency sweep, determined by rheometer.

It was, therefore, concluded that the FPD is well suited and applicable for measuring the firmness of mayonnaises. It is a flexible instrument that is applicable in an industrial environment due to its punctual analyses of rheological characteristics and its ease of use.

Key words: *Foodtexture Puff Device, mayonnaise, rheology, firmness*

1. Introduction

Quality is a concept that connects multiple options such as: uniform foodstuffs colour or crispy, fragrance that suits this product or raw materials from which it is made, etc.. According to this, the quality of food or a product is very difficult to maintain and describe (Claes 2011).

Fortunately, there are features that can be directly linked to the quality of the food, appropriate such characteristic is rheology. Rheologycal properties nag a clear picture of the characteristics of a substance. Rheologycal characteristics often largely based on complex measurement methods such as Bostwick konsistometer, sometimes giving the lack of necessary information. For companies and food production process which used testing different products would be useful to have a device, an instrument that operates on a simple and accurate way to describe rheology to these products. There rheometers are easy to operate and precise measurement, but have their own disadvantages. Some of the shortcomings is the design and method of managing of instruments, and the high cost of these devices that cannot afford the smaller manufacturing companies for the food production. Another disadvantage is that already tested food can't be used again.

Foodtexture Puff Device (FPD) can be described as non destructive device that emits air at the surface of the sample for testing. At the same time FPD sends a laser beam on the surface of the sample with the laser lens and laser sensor measure distortion, wavy surface caused from air puffs.

This researching is part of big project, in mind has its performance test which can be applied in the food industry. Test project is divided into three research groups of foodstuffs. In the first group of food items and products with viscous properties as: foods with sugar, glucose syrup and fructose paste. The second group of products with yield properties such as oils, fats and chocolate. In the last group belong to products with high elastic properties as gluten flours and mixes with water. Past publicized scientific publications show that FPD can be used as a successful instrument in determining rheology in some of the above foods. The ultimate goal of the project is to make a good FPD practical guide that could be used in industry (Sofie Morren 2012).

This study take small part of the project and is focused on research and testing the applicability of the FPD to determine rheologycal properties of o/w emulsions. Specifically, this type of emulsion which is researched mayonnaise.

This instrument is used as an alternative method for rheological properties, while Rheometer Physica MCR 301 and Texture Analyser TA.XT.plus Stable Micro Systems have been used as reference instruments and methods for comparing the results obtained from the FPD.

2. Material and Methods

Eight commercial mayonnaise-type products were analyzed with the FPD, a Texture Analyser (spreadability rig) and the rheometer (storage and loss module from a frequency sweep). It was tested at three different selected temperatures with all instruments.

2.1. Foodtexture Puff Device (FPD)

FPD as an instrument for measuring the strength of the food products, without their destruction was first used by (Stanley E. Prussia 1994). These ways of measuring patented by them and are based on the use of injected air and light lens. Several characteristics are essential for productions of this invention: Measurements without contact, the sample is not destroying and is adjustable objects which have variable surface features. FPD actually injected controlled air puffs on the sample testing surface creating deformations that are observed by a laser sensor that measures the distance to the surface.

Vividly work FPD is shown below, and was first used for measuring the coagulation of milk by (F. R. Bamelis 2006).

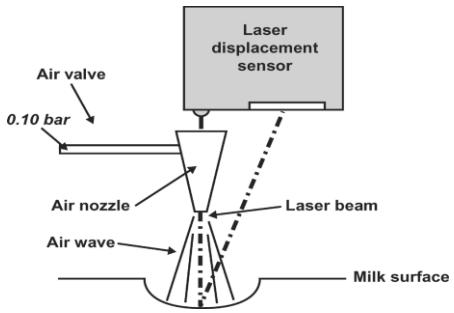


Figure 1. Measurement head of FPD (F. R. Bamelis 2006)

Firmness is resistance, and is a key factor in determining the quality of food products. Customers choose the strength as a factor when choosing to buy. Information and data resulting from the changes of surface tested sample deformation was sent to personal computer where they are processed and presented in tables and graphics through special adapted software - Labview 5.3 National Instruments (F. R. Bamelis 2006).

2.2. Rheometer Physica MCR 301

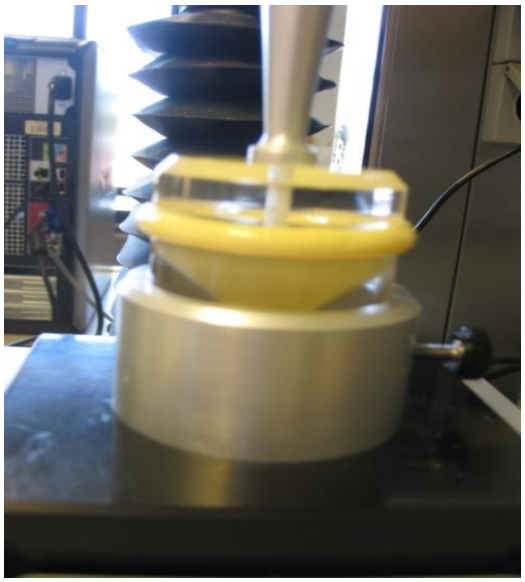
This instrument, Rheometer Physica MCR 301, was used as a reference method to compare the results of the examination. Rate of shear test method was commonly found in the reference data. Spindle is tool who descends down to the head of Rheometer Physica MCR 301 on which was applied the testing sample. Plate on plate system was used, with a diameter of 25mm. Was used calibration option, zero GAP, 0 mm connecting surface between spindle and head of the instrument.

Picture 2. Reometer (Anton Paar Physica MCR 301) with spindle PP25

Was used two types of test: oscillatory and rotation test. From oscillatory test was measured storage and loss module from a frequency sweep and the rotation test was used for CSR (constant Rhear Rate) & SRR (Shear Rate Ramp) tests. With these two tests can be determined (γ, η, φ, $\dot{y}$) (Germany 2006).

2.3. Texture Analyser TA.XT.plus

The (TA.XT.plus) Texture Analyser (Stable Micro Systems Ltd, Godalming, Surrey, UK), with the "TTC Spreadability Rig" (HDP/SR) attachment, was used as the reference analysis for the evaluation of the spreadability of the emulsions. This setup has previously been used to assess the spreadability of table fats by (Glibowski 2008). The testing of the prepared samples repeat 5 times for each sample. For each test, cone tests are set special place in already centered base of 25mm. The male cone section ranges from the top down in a distance of 23mm with speed of 3mm / s, with penetration in tested mayonnaise, which is filled the female cone. The force required for penetration of the male part into the female part, pushing the mayonnaise on the outside, is registered on the computer monitor.



Picture 3. TA.XT2+ with Spreadability Rig

2.4. Data analysis

For all three instruments, the FPD, Rheometer Physica MCR 301 and the TA.XT2+, data treatment was performed in Office Excel 2007. All statistical tests were performed with SPSS. ANOVA tests were performed to differentiate between batches and curve estimation was used to correlate results from the FPD and the texture meter. Tests were decided on the 0.05 significance level, unless specified differently.

3. Results and Discussion

The Food Texture Puff Device was tested for the applicability of mayonnaise. This research was part of a larger project, aiming to draw up a best practice guide for businesses on the FPD. In this study, the rheometer and texture analyzer as reference method.

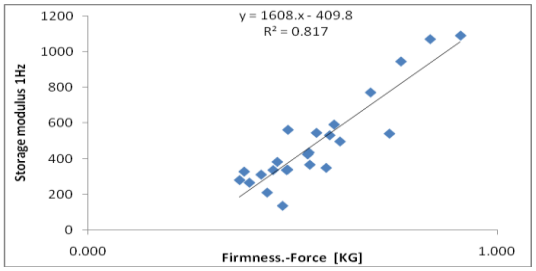


Figure 2. linear correlation of the Storage modulus 1Hz to the Firmness

This figure relates the storage modulus from the rheometer with the force of the spreadability rig. It shows how the two "reference measurements" are related with each other.

Figure 3 displays a significant correlation between result from the FPD and the Rheometer. On one curve is showed relates all samples at all temperatures. The correlation is described by a exponential function.

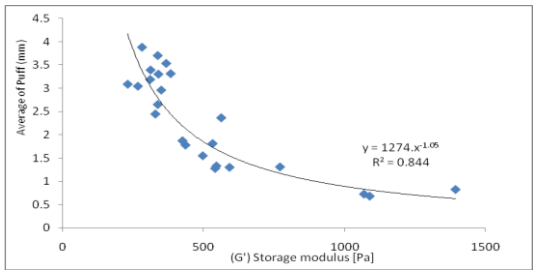


Figure 3. Exponential correlation of the maximum deformation to the Storage modulus

Figure 4 displays a significant correlation between result from the FPD and the texture analyzer. On one curve is showed relates all samples at all temperatures.

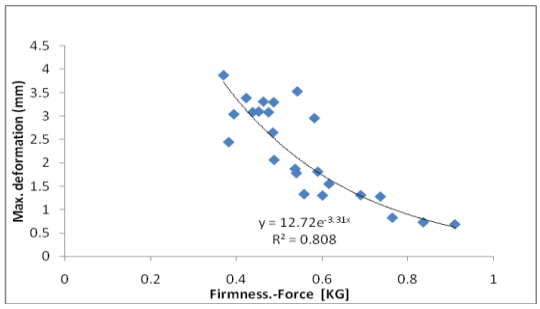
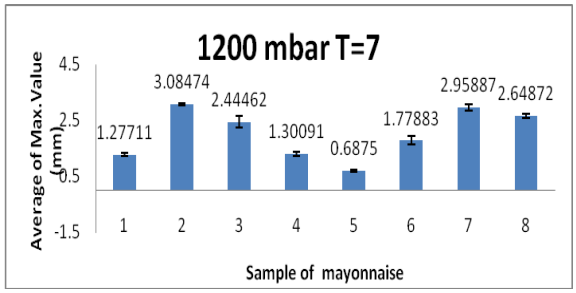
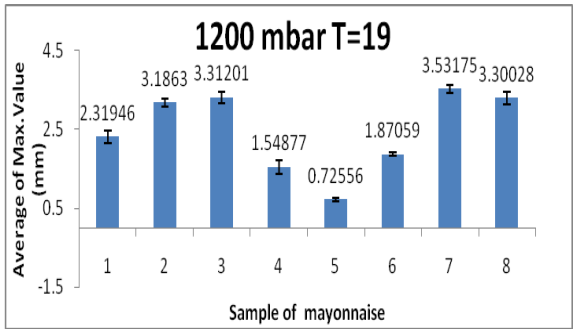


Figure 4. Exponential correlation of the maximum deformation to the Firmness





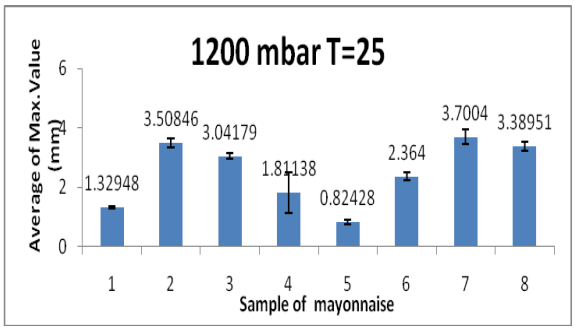


Figure 5. Maximum deformation (puff 1) for eight different batches of mayonnaises as measured with the FPD. The test displayed here were conducted at 7^0, 19^0, 25°C.

The combination of these three figures is important to illustrate the order magnitude of the standard deviations on the FPD measurements and that the FPD is capable to distinghuish different mayonaise samples.

The FPD is capable to study the influence of temperature, because for all mayonaise samples, the deformation at 7°C is lower than at 19°C (which is expected, because mayonaise is less firm at higher temperature). The deformations at 25°C are not always higher than at 19°C, but the difference in temperature is also rather small (only 6°C).

4. Conclusions:

In particular, the temperature effect on the viscosity was considered to be important rheological property of the oil or fat. The rheometer studied the temperature effect on the viscosity. The results showed, as in the literature, a viscosity decrease with increasing temperature. The first challenge of the study, the oils and fats perceptible for the FPD. The FPD is a good method and gave a wider range of the results than the rheometer.

The comparison of the FPD with a texture analyser revealed that the maximum deformation created by the FPD is strongly correlated to the firmness of the emulsions. The Foodtexture Puff device was capable of the same discriminating force as the texture analyser, when using the results solely by using the results of Puff's.

The use of the FPD by means of a guide best practice, delivers to a company has a simple method to gain insight into the rheology of mayonnaise. It is capable of accurate, in-depth measurements in a laboratory environment and has the flexibility and ease-of-use, required for measurements in a factory environment.

5. References

Claes, S. (2011). Toepasbaarheid van het Foodtexture Puff Device voor reologische metingen van oliën en vetten. Industriële en Biowetenschappen. Geel, Belgium, K.H.Kempen.

F. R. Bamelis, J. G. D. B. (2006). "Use of the Foodtexture Puff Device to Monitor Milk Coagulation." American Dairy Science Association 89(1): 29-36.

Germany, A. P. (2006). Rheoplus Software Volume 1 - Installation & Introduction. Ostfildern, Germany, Anton Paar Germany GmbH. Printed in Austria. 1: 31.

Glibowski, P., Zarzycki, P., & Krzepkowska, M. (2008). "The Rheological and instrumental textural properties of selected table fats." International Journal of Food Properties: 678-686.

Sofie Morren, T. V. D., Frank Mathijs, Bart De Ketelaere, Johan Claes (2012). Applicability of the Foodtexture Puff Device for rheological measurements on food products. L. F. S. a. N. R. Centre. Wien, IWT: 1.

Stanley E. Prussia, G. J. J. A., Stone Mountain; Bob Hewlett, Lilburn; Yen-Con Hung, Peachetree City, all of Ga (1994). Non destructive firmness measuring device. USA, The University of Georgia Research Fondation, Inc., Athens, Ga. 5,372,030: 11.