Relation between rheology and thickness suitability in prebiotic desserts with different composition

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INTRODUCTION

Some rheological parameters have been previously used to explain the differences in the intensity of the perceived thickness among food products.[1] However there is less information relating rheology and hedonic consumer evaluation of thickness. Just about right (JAR) scales can be used to evaluate how the intensity of a product is perceived by consumers.[2] The aim of this study was to determine in semisolid dairy desserts, the most suitable level of thickness and to relate with rheological parameters.

MATERIALS AND METHODS

Samples composition

Ingredients: skimmed milk powder (Central Lechera Asturiana, Spain), modified tapioca starch (C* CreamTex 75,720, Cerestar, Spain), a mixture (50:50) of two inulin types: long-chain (Frutafit ® TEX) and short chain (Frutafit ® CLR) (Sensus, Brenntag Química, Spain), commercial sucrose, mineral water (Font Vella), lemon flavor 16508ª (Lucta, Spain),colorant T-PT8-WS (CHR Hansen, Spain) and preservatives: potassium sorbate and potassium benzoate (Panreac, Quimica SA, Spain).

A set of 19 dairy dessert samples were prepared varying inulin concentration from 3 to 6 %, sucrose concentration from 4 to 16% and lemon flavour concentration from 25 to 225 ppm, according to a central composite design. All samples included fixed amounts of starch (3.75 %), milk (75 %), colorant (37.5 ppm) and and preservatives (potassium sorbate 500 ppm; potassium benzoate 500 ppm).

Sample preparation

Starch, sucrose, milk and colorant were weighed in a flask and mixed for 10 min. The flask was placed in a water bath at 97 ± 1 °C and stirred 25 min. Then the sample was cooled in a water bath at 20°C with stirring for 10 minutes. Finally the lemon flavor, preservatives and the water evaporated in the process were added. The samples were transferred to a closed flask and stored under refrigeration (4±1°C) during 96 h.

Rheological measurement

All rheological measurements were carried out at 10±1°C in a controlled stress rheometer (RheoStres, Karlsruhe, Germany) using a parallel-plates sensor system (6 cm diameter and 1mm gap).
Flow behaviour was measured by recording shear stress values when shearing the samples at linearly increasing shear rates from 1 to 200 s-1 through 60 s and down in reverse sequence for the same time. Viscoelastic properties were measured using small amplitude oscillatory shear tests.

Sensory evaluation

Sensory evaluation was carried out in a standardized test room. Samples (40 ml) were served at 10±1°C in white plastic cups coded with three digits random numbers.
A total of 100 consumers evaluated the suitability of each sample thickness using a 5-point just about right (JAR) scale (1 = too weak, 3 = just about right; 5 = too strong).

REFERENCES

1. T. Van Vliet (2002). *Food Quality and Preference*, *13*, 227–236.
2. M. Gacula, S. Rutenbeck, L. Pollack, A.V.A. & H.R. Moskowitz (2007). *Journal of Sensory Studies*, *22*, 194–211.

RESULTS AND DISCUSSION

Rheological properties. Effect of composition

All samples showed time dependent and pseudoplastic flow behavior and viscoelastic properties typical of weak gels with G' values above those of G'' (Fig. 1). Rheological parameters values varied with composition according to models in Table 1

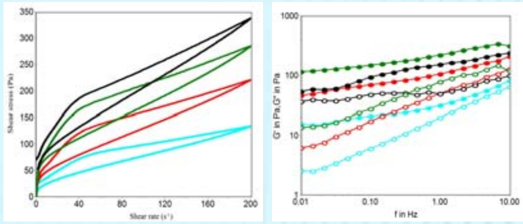

Figure 1. Flow curves and mechanical spectra of dairy desserts

Table 1. Regression models relating rheological parameters with inulin (I) and sucrose (S) concentrations

Parameter	Model
Thixotropic Area	233.62 S + 520.19 I
Consistency Index	$0.624 + 0.103\ S^2 + 0.435\ I^2$
Apparent Viscosity at 10 s^{-1}	$0.429 + 0.026\ S^2 + 0.095\ I^2$
Elatic Modulus	$-50.30 + 0.89\ I^2 + 1.88\ SI$
Loss Tangent	1.125 – 0.020 S – 0.071 I

Thickness suitability assessed by consumers. Effect of composition

For each sample the percentage of consumers that considered thickness in a certain way (too much, JAR or too little) is shown in Figure 2. Consumers considering thickness as JAR varied among samples depending on both sucrose (S) and inulin (I) concentration (Eq.1, Fig. 3). The most adequate thickness would correspond to samples with intermediate levels of inulin and sucrose. Due to the interaction effect, the combination of low sucrose-high inulin and vice versa also would led to samples with adequate thickness.

Equation 1

$$\%\ \text{Consumers in JAR 3} = -407.60 + 82.66\mathbf{I} + 47.99\mathbf{S} - 3.83\mathbf{I}^2 - 1.26\mathbf{S}^2 - 3.94\mathbf{SI}$$

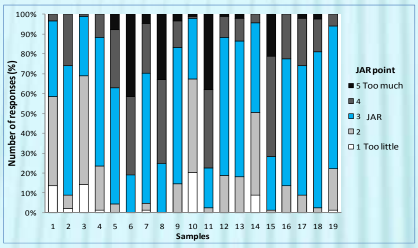

Fig. 2. Distribution of consumer assessments about the thickness appropriateness of samples.

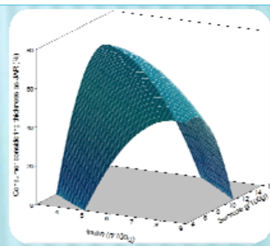

Fig. 3. Response surface of the relation between the percentage of consumers considering thickness as JAR and sample composition.

Relationship between rheological properties and thickness suitability

Consistency index and storage modulus showed to be related with the thickness adequacy. The ranges of values associated with desirable thickness level were different depending on the approach:

1) Approach based in the percentage of consumers considering thickness as JAR (Fig.4). The range of K and G' values corresponding to an adequate level of thickness (more than 60% consumers considering JAR) were 25-37 Pa.s^n and 73-112 Pa, respectively.

2) Approach based in thickness JAR deviations (Fig.5). Samples showing no relevant deviation from adequate thickness level showed K and G' values in the ranges between 25 and 31 Pa.s^n and 73 and 100 Pa, respectively.

K and G values within 31-37 Pa.s^n and 100-112 Pa, respectively were exclude in the second approach because although thickness level was considered for a great part of consumer as JAR the rest of them agreed in considering it too thicker.

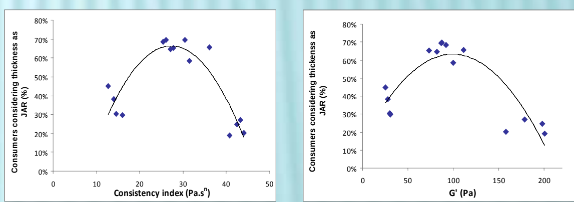

Fig. 4. Relationship between percentage of consumers considering sample thickness as adequate and both consistency index and storage modulus values.

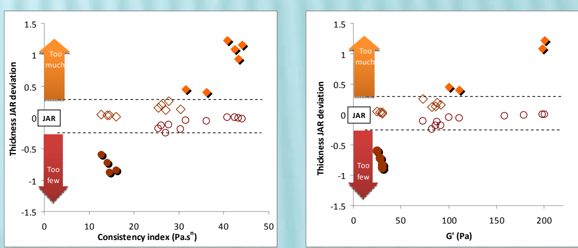

Fig. 5. Relationship between JAR thickness deviation and both consistency index and storage modulus values.

CONCLUSION

JAR methodology is a useful tool for the assessment of attribute adequacy. Data thus obtained can be related with instrumental measurements to determine which parameters and ranges of them can be taken as indicators of the desirable level of the attribute.

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