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Simple Rheological tests to assess the swallowing capacity of foods

INTRODUCTION

Empirical rheological tests are commonly performed in the industry, in order to predict the processability of materials. For practical reasons, they have to be easily handled, to require short measurement time, and, ideally, their relevance should be ascertained by a **comparison with scientific rheological measurements**.

Regarding food, these constraints are not only requested for processability, but also to predict **sensory properties** and the capacity of the food to be **swallowed safely**. For instance, this last property is essential for individuals suffering from **dysphagia**.

Objectives of this work :

- To propose a classification of empirical rheological tests
- To present two different methods used for the characterization of **food products**, here **thickened drinks**.
- To delineate their main **limitations** and the necessity of carefully **choosing** the rheological test according to the needs and the type of product to assess.

Classification of simple rheological tests

We propose a **non-exhaustive** classification of methods that are not only related to foods. Methods developed in other fields are of great interest particularly in the oil, paint and concrete industries where the **control of texture** or **consistence** is mandatory for a steady processing. The main purpose of covering a wide variety of tests is to be able to select the most **relevant** one according to the needs of applications.

1. Imposed Stress

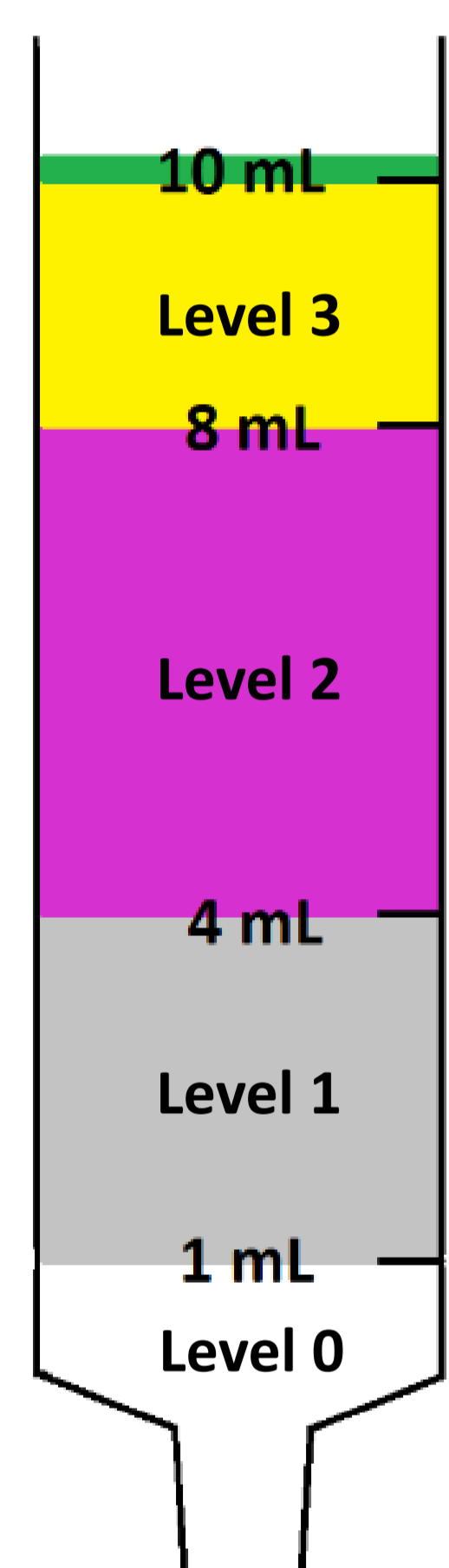
2. Imposed Strain Rate

1. Imposed Stress		2. Imposed Strain Rate	
Collapsing Tests	Gravity Flow Tests	Induced Flow Tests	
Slump test	Capillary Viscometer (U-shaped, Ostwald)	Capillary Piston Viscometer (MFI, ...)	Truck Mix Rotational Viscometer (Brookfield, Couette)
Line-Spread Test	Funnels (Marsh, Posthumus, Flow Cups, IDDSI Flow Test)	Falling Ball Viscometer	Vane Test
Bostwick Consistometer			Vibrational Viscometer

TESTS OVERVIEW

FLOW TESTS : Funnels and the Syringe Flow Test

COLLAPSING TESTS : The Line-Spread Test



The syringe flow test (SFT) is used to characterize the texture of drinks in the frame established by the International Dysphagia Diet Standardization Initiative (IDDSI)¹.

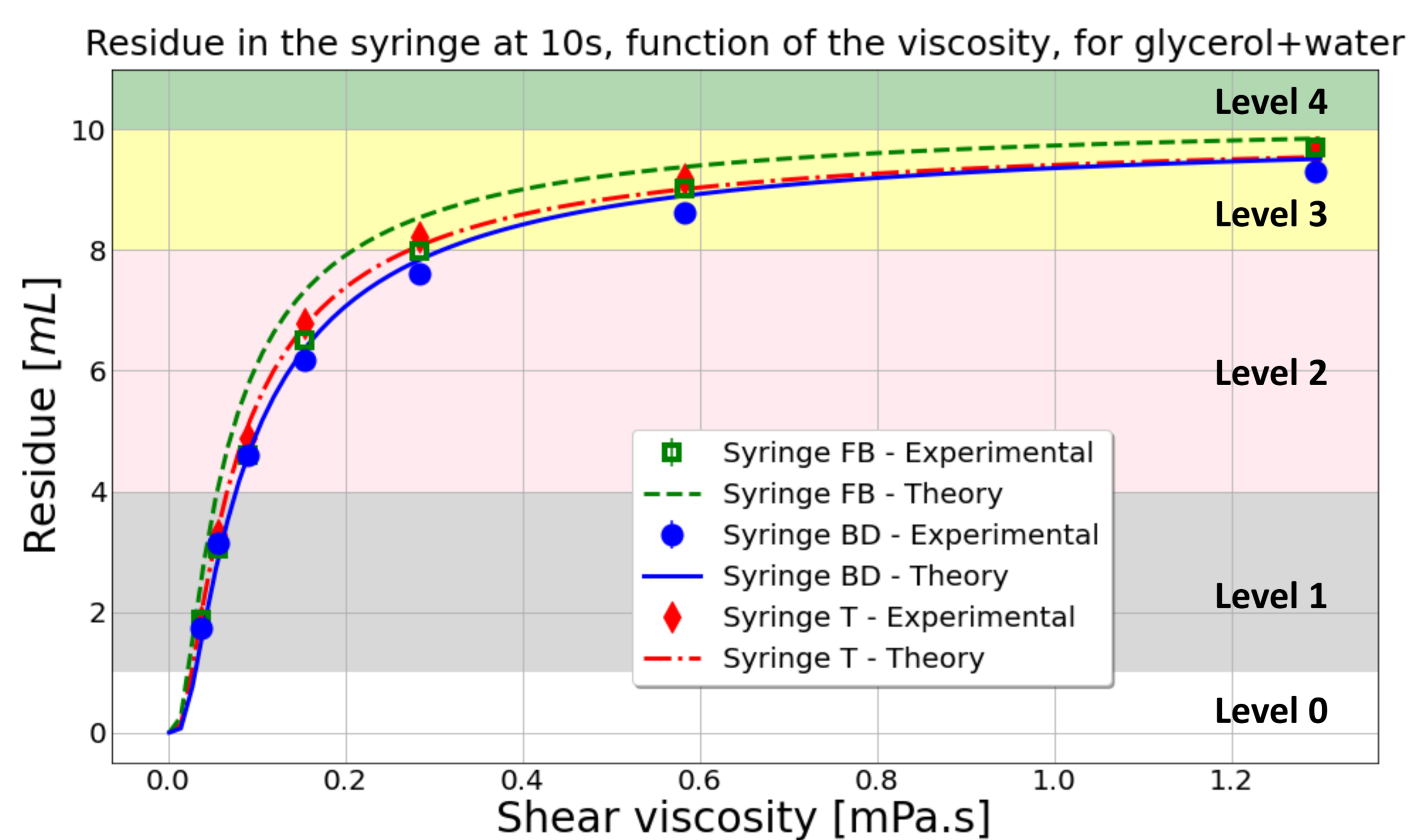
By allowing 10mL of fluid to flow during 10 seconds under hydrostatic pressure, the users can report the volume left in the syringe and link it to a texture level, from **thin drinks** (Level 0) to **moderately thick** (Level 3).



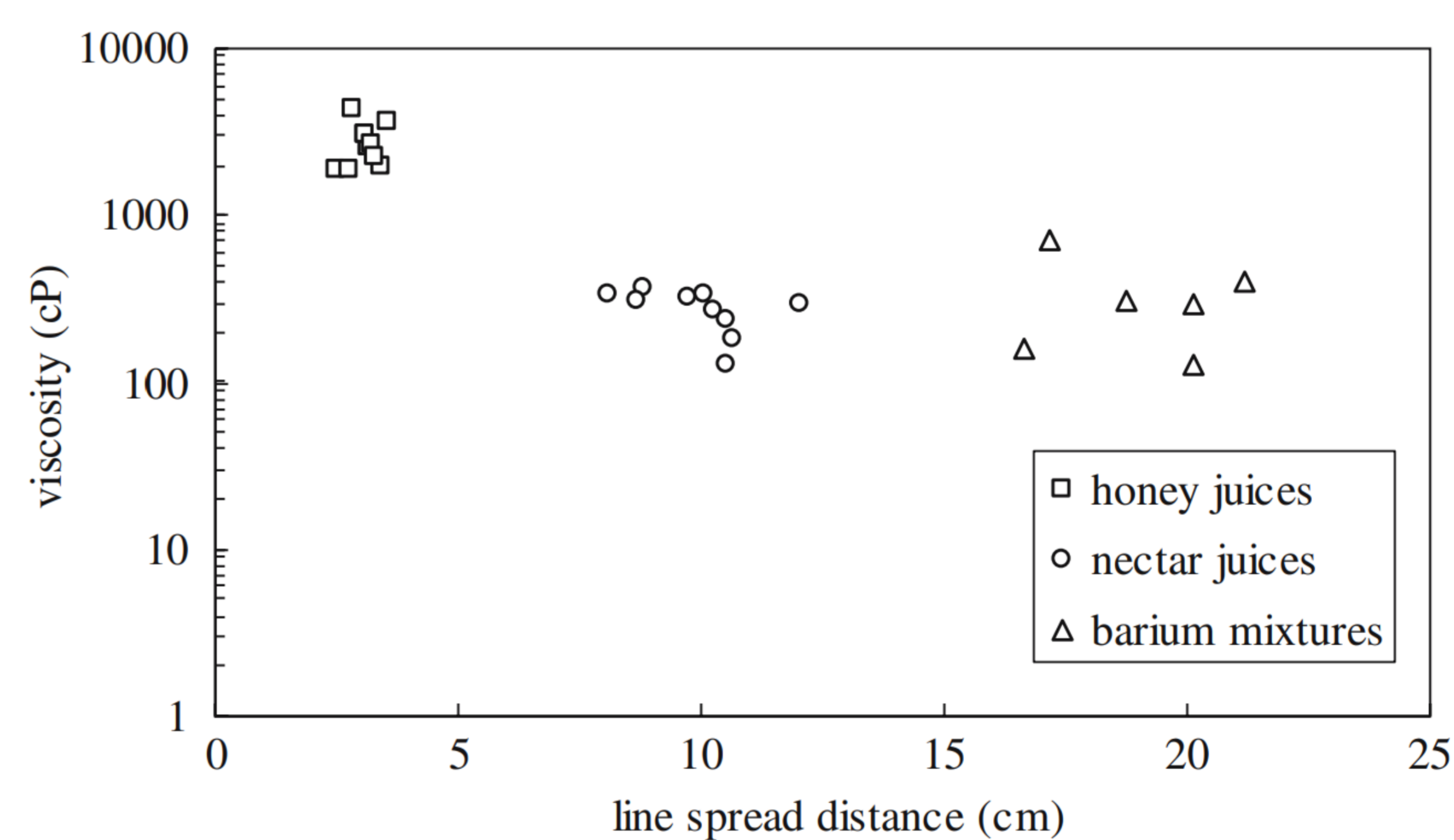
Kim et al. (2018)

The line-spread test (LST) consists of a cylindrical cookie cutter of 3.5cm height and 5cm diameter which is filled with the thickened beverage, lifted, and allowed to flow on a plane surface marked with concentric circles for 60s.

This method characterizes texture of thickened drinks in the classification of the National Dysphagia Diet Task Force (NDDTF), **thin**, **nectar-like**, **honey-like**.



It is recommended to respect a precise length of syringe¹ (BD Syringe). But, it has been shown² that the flow in the syringe is highly sensitive to change in the nozzle diameter because the flow rate depends on the nozzle diameter power 3.



Nicosia & Robbins (2007)

The LST is able to correctly separate the fluids according to the NDDTF classification, but cannot provide an accurate assessment of viscosity for fluids of similar texture³. Although close to the slump test where the final height is also measured, and linked to a yield stress τ_0 ⁴, the LST cannot be predictive of rheological parameters.

Most other funnel tests link the **total efflux time** t_f to a viscosity or apparent viscosity η . For Newtonian fluid a simple calibration with water allows to obtain α , a **coefficient** accounting for the **geometry**.

$$\eta = \frac{\rho g}{\alpha} t_f$$

Both the **IDDSI Flow test** and the **Line-Spread test** are used to characterize the same type of food product, but, depending on the thickeners used, one might be more relevant than the others, for instance the IDDSI tests proved its use for **xanthan gum-based thickeners**^{5,6} while the line-spread test has shown to be more relevant for **starch-based thickeners**⁵.

CONCLUSION

+ These tests are highly valuable because

- Not time consuming
- Do not need extensive trainings
- Are affordable

- However these tests

- Lack objectivity
- Are dependent on geometry
- Do not consider the effect of saliva

Those tests have greatly improved the care of people with dysphagia disorder and thus their quality of life, but it is important to carefully choose them.

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