Guide to skilled food rheology

From ingredients to final products

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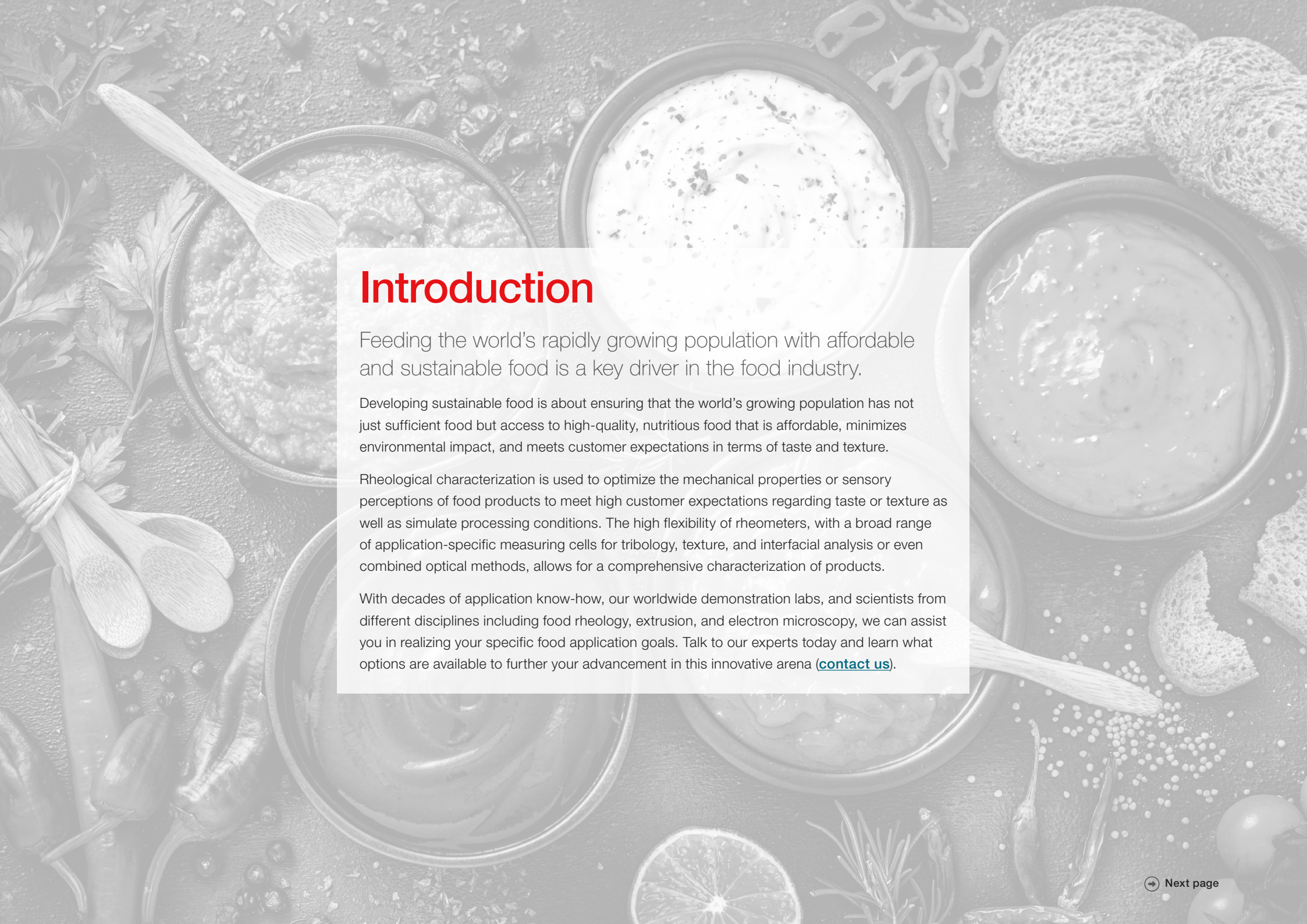

Introduction

Feeding the world's rapidly growing population with affordable and sustainable food is a key driver in the food industry.

Developing sustainable food is about ensuring that the world's growing population has not just sufficient food but access to high-quality, nutritious food that is affordable, minimizes environmental impact, and meets customer expectations in terms of taste and texture.

Rheological characterization is used to optimize the mechanical properties or sensory perceptions of food products to meet high customer expectations regarding taste or texture as well as simulate processing conditions. The high flexibility of rheometers, with a broad range of application-specific measuring cells for tribology, texture, and interfacial analysis or even combined optical methods, allows for a comprehensive characterization of products.

With decades of application know-how, our worldwide demonstration labs, and scientists from different disciplines including food rheology, extrusion, and electron microscopy, we can assist you in realizing your specific food application goals. Talk to our experts today and learn what options are available to further your advancement in this innovative arena (**contact us**).

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Food rheology requirements

From production to consumption, rheological properties play an important role during the entire life cycle of liquid or semi-solid food formulations. Rheological measurements with different types of instruments are performed in the food industry on a daily base. Here are some common examples:

- Simple single-point viscosity measurements for a fast batch release in production
- Flow curve or yield point measurements in the quality control laboratory
- Comprehensive rheological investigations such as mouthfeel, swallowing, or chewing behavior for the development of new formulations in the research and development department

Processability, stability, and consistency are the attributes that determine consumer perception and thus the overall acceptance of the final product. They can be investigated with various rheological test protocols. In food production, every stage requires different instrument capabilities.

Modern viscometers and rheometers are available to help navigate daily measurement needs from development to QC.

	Ball bearing models		Air bearing models			
						
	Viscotester iQ Rheometer	MARS iQ Rheometer	Viscotester iQ Air Rheometer	MARS iQ Air Rheometer	MARS 40/60 Rheometer	
Rotation mode	✔	✔	✔	✔	✔	Methods
Creep and recovery	X	X	✔	✔	✔	
Oscillation model	✔	✔	✔	✔	✔	
Squeeze, break- penetration tests	X	✔	X	✔	✔	
Tribology	X	✔	X	✔	✔	Accs
Interfacial rheology	X	X	X	X	✔	
Hyphenated methods	X	X	X	X	✔	
Low viscous fluids (beverages)			✔	✔	✔	Samples
Medium to high viscous fluids	X	X	✔	✔	✔	
Semisolids (mayonnaise, mustard)	✔	✔	✔	✔	✔	
Solids (meat analog, cheese)	X	✔	X	✔	✔	
	Quality control				Development/ formulation	

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Flow behavior of chocolate melts

Viscosity and yield stress hold outsized importance when making chocolate

The flow behavior of molten chocolate is a crucial property for many reasons. During production, the various transportation, filling, dipping, coating, or dosing steps depend on a precisely defined viscosity and yield stress. The finished chocolate's properties, such as its surface's appearance or mouthfeel, are also directly related to the viscosity behavior of the chocolate.

In this application note, the rheological properties of two different chocolate samples were measured according to ICA Method 46 with a HAAKE Viscotester iQ Rheometer with Peltier and HAAKE RheoWin Software.

Read the application note

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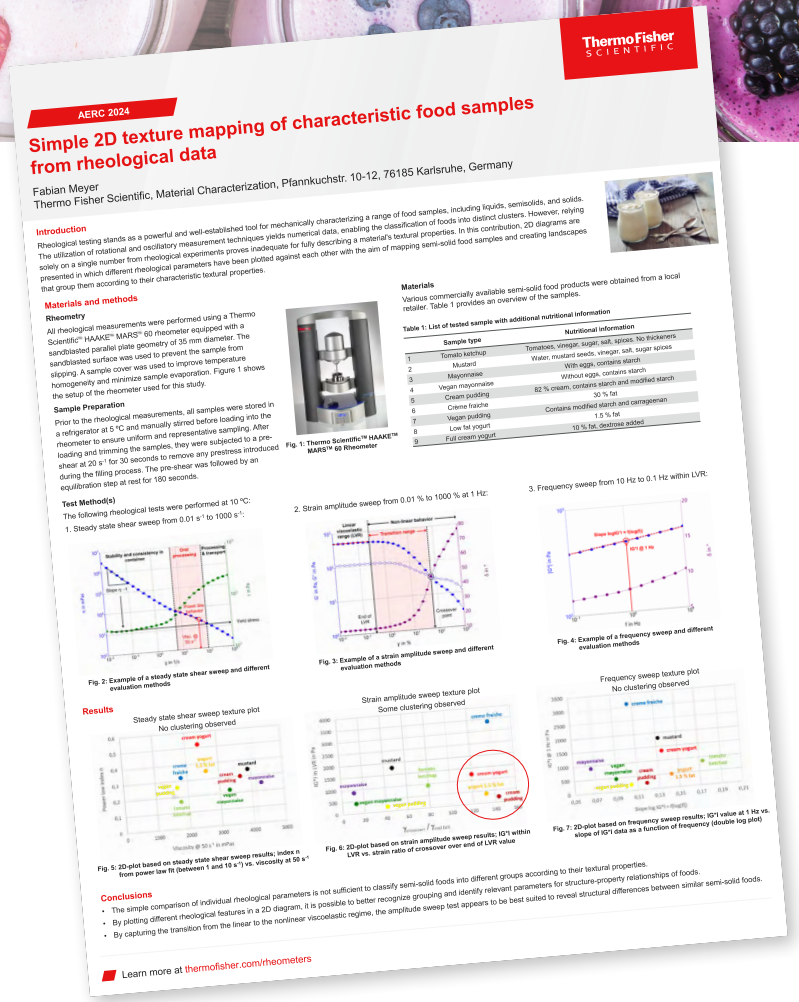
Simple 2D texture mapping of characteristic food samples from rheological data

Categorize thickened food products using distinctive textural attributesin new end products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Simple 2D texture mapping of characteristic food samples from rheological data

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Introduction

Materials and methods

Rheometry

Sample Preparation

Test Method(s)

Materials

Table 1: List of tested sample with additional nutritional information

	Sample type	Nutritional information
1	Tomato ketchup	Tomatoes, vinegar, sugar, salt, spices. No thickeners
2	Mustard	Water, mustard seeds, vinegar, salt, sugar spices
3	Mayonnaise	With eggs, contains starch
4	Vegan mayonnaise	Without eggs, contains starch
5	Cream pudding	82 % cream, contains starch and modified starch
6	Crème fraiche	30 % fat
7	Vegan pudding	Contains modified starch and carrageenan
8	Low fat yogurt	1.5 % fat
9	Full cream yogurt	10 % fat, dextrose added

Fig. 1: Thermo Scientific™ HAAKE™ MARS™ 60 Rheometer

Fig. 2: Example of a steady state shear sweep and different evaluation methods

Fig. 3: Example of a strain amplitude sweep and different evaluation methods

Fig. 4: Example of a frequency sweep and different evaluation methods

Results

Steady state shear sweep texture plot
No clustering observed

Strain amplitude sweep texture plot
Some clustering observed

Frequency sweep texture plot
No clustering observed

Fig. 5: 2D-plot based on steady state shear sweep results; index n from power law fit (between 1 and 10 s⁻¹) vs. viscosity at 50 s⁻¹

Fig. 6: 2D-plot based on strain amplitude sweep results: |G*| within LVR vs. strain ratio of crossover over end of LVR value

Fig. 7: 2D-plot based on frequency sweep results: |G*| value at 1 Hz vs. slope of |G*| data as a function of frequency (double log plot)

Conclusions

- The simple comparison of individual rheological parameters is not sufficient to classify semi-solid foods into different groups according to their textural properties.
- By plotting different rheological features in a 2D diagram, it is possible to better recognize grouping and identify relevant parameters for structure-property relationships of foods.
- By capturing the transition from the linear to the nonlinear viscoelastic regime, the amplitude sweep test appears to be best suited to reveal structural differences between similar semi-solid foods.

Learn more at thermofisher.com/rheometers

Overview

Rheological testing is a powerful and well-established tool for mechanically characterizing a range of food samples, including liquids, semisolids, and solids. However, relying solely on a single number, such as the apparent viscosity at a specific shear rate, proves inadequate for fully describing a material's textural properties. A more comprehensive investigation is necessary here, especially if different foods are to be grouped and classified according to their rheological behavior.

This scientific poster examines the results of three rheological tests conducted on nine different semi-solid food products. Taking the right parameters and plotting them against each other in a 2D diagram can help to identify similarities and better understand structure-property relationships of foods.

View the poster

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The potential of tribo-rheometry in food

Know that your new innovative food will have customer acceptance

Tribo-rheometry is a valuable technique used in the food industry to assess the rheological properties of food products. Measuring the frictional forces generated during the mastication and swallowing of food materials helps in understanding their texture, stability, and sensory attributes. This information is crucial for optimizing food formulations, enhancing product quality, and improving consumer satisfaction.

Webinar

Introduction to tribo-rheometry (18 minutes)

Dive into the world of tribology and learn how to perform tribo-rheometrical measurements on rotational rheometers across industries.

Watch the webinar

Video

Tribo-rheometry solution for Thermo Scientific HAAKE Rheometers

Discover the tribo-rheometry capabilities of HAAKE Rheometers for food applications.

Watch the video

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Advantages of hyphenated rheo-spectroscopy and rheo-microscopy in food development

See more with multimodal analytical techniques

The combination of two complementary measurement techniques at the same time can reveal more information about a food's properties than either one of them individually. Explore these two application notes to see examples.

Application note

Cocoa butter crystallization measured with a Rheo-Raman setup

Simultaneous rheology and Raman spectroscopy measurements enable the examination of the isothermal crystallization of cocoa butter.

Read the application note

Application note

Investigating heat-induced gelation of whey protein using simultaneous rheology and FTIR spectroscopy

Simultaneous rheological and FTIR spectroscopic measurements allow the gelation process of whey protein to be studied.

Read the application note

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Food resource center

Application laboratories

Our fully equipped application laboratories are in constant demand for testing customer samples and developing and optimizing pioneering applications. We provide a broad range of product and application solutions, and our team of application scientist and interdisciplinary technique specialists is on hand to answer your questions (**contact us**).

Register for application and product information at **thermofisher.com/specoptin** to gain access to the latest resources to accelerate your research and improve laboratory productivity.

Seminars and trainings

Comprehensive training programs, in-house seminars, and practical rheology and extrusion courses in various locations around the world. We support our customers with comprehensive on-demand training (webinars, videos, and application notes) from our experts, and benefit from our interdisciplinary knowledge in food science and technologies.

Interested in food sustainability?

Read our compendium, food extrusion and rheology in alternative protein formulations and valorization of food side-streams.

Webinar

What rheology can do for food

From rheology to mouthfeel

Do you know that rheology plays a crucial role in determining the sensory attributes, stability, and processing characteristics of various food products.

By studying the flow behavior and texture of food, researchers can design formulations and processing conditions to achieve desired sensory attributes and ensure product stability.

Watch the webinar

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Food rheology: **thermofisher.com/foodrheology**
Food extrusion: **thermofisher.com/plantbasedmeat**

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