Tribology and food texture perception

Identification

Key words
food texture, tribology, tribometer, lubrication properties, in-mouth sensory attributes, friction coefficient, oral food processing

Latest version
2012/12/06

Completed by
KU Leuven LFT

How does it work?

Primary objective
Assessing and interpreting in-mouth sensory attributes, since oral food manipulations can be mimicked by tribological techniques.
Working principle

Texture is a critical food quality parameter that affects the consumer acceptance. Food texture encompasses all sensory attributes perceived during handling and eating of a food [1]. In conventional food textural characterisation, the response to bulk food deformation (food rheology) enables the determination of the perceived texture. So far, this method only mimics deformation during handling and/or at early stages of the eating process, thereby resulting in an incomplete or inaccurate elucidation of food texture and particularly, the oral perception of texture.

Oral perception of texture depends on the bulk food response to initial deformation between the teeth (early stage of eating process) and to the manipulations of softened and/or thinned food between the saliva-lubricated tongue and palate (later stages of oral food processing). While initial deformations can be mimicked by rheological testing, other in-mouth food manipulations can be mimicked by lubricated interacting surfaces in relative motion, that is tribological testing [2]. This implies that oral perception of food texture is generally associated with a combination of bulk and lubricated thin film properties, that is both the rheological and tribological properties of foods [1,3-5]. During oral food processing, textural properties that are related to food rheology are detected relatively quickly (e.g. sensory thickness which is related to viscosity), whereas those associated with (oral) tribology are sensed relatively slowly. Thin film-related properties are mouthfeel attributes, which include creaminess, smoothness, slipperiness, astringency, stickiness, etc. Tribology is the science of friction, lubrication and wear of interaction surfaces in relative motion [1,4]. The most important parameter in tribological testing is the friction coefficient. Although this constant depends only on the properties of the interacting surfaces (when they are in dry movement), in the particular case of thin films, it can vary significantly with the surface load and fluid viscosity and, thus, the lubrication regime [6]. Surfaces in relative motion will either 1. be contacting each other (boundary lubrication regime and high friction coefficient), 2. be completely separated by a thin layer of fluid (hydrodynamic lubrication regime and lower friction coefficient), or 3. almost be touching each other (mixed lubrication regime and friction coefficient is minimal at the junction between mixed and hydrodynamic regimes).

In oral tribology, the lubrication regime depends on the stage of oral processing. For example, for thin fluids (such as beverages) the initial lubrication regime which is dominantly hydrodynamic, gradually becomes dominated by mixed and boundary lubrication as the fluid is consumed. In addition, the perception of a sensory property is associated with specific lubrication regimes. In studying sensory properties of guard solutions (rather thick fluid), Malone et al. [3] indicated that the sensory perception of smoothness and slipperiness were dependent on the friction coefficient measured in the mixed lubrication regime. Although food tribology is quite recent, this approach has been used for evaluating and understanding the perceived oral texture of semi-solid foods [7-9].

Images

Additional effects

Important process parameters

Important product parameters

In food tribology, the lubrication properties of critical food molecular constituents can also be assessed [10]. Food tribology also enables a better understanding of food oral processing [1,3].

In oral tribology, the tongue and palate, which constitute the test fixtures, slide at specific speeds while the food-saliva mixture acts as lubricant. In order to accurately determine perceived in-mouth sensory attributes, using either a tribometer or a rheometer equipped with tribology cell, test conditions such as the nature, behaviour and speed of the test fixtures, lubrication regime (sample thickness) and solvent composition (simulates saliva) must allow accurate capture of the complex actions that occur during oral tribology.
What can it be used for?

**Products**
- Fluids, semi-solid foods

**Operations**
- Product development, food characterisation

**Solutions for shortcomings**
- Quality control of structurally engineered functional and healthy foods

What can it NOT be used for?

**Products**
- Solid foods, particulate foods

**Operations**
- Further processing (heating or microwaving prior to consumption) of engineered foods may change the tribological characteristics of texture-defining molecules and, thus, alter the sensory properties of the food.

**Other limitations**
- None

**Risks or hazards**
- None

Implementation

**Maturity**
- Limited industrial application (if any)

**Modularity**
- Quality control

**/Implementation**

**Consumer aspects**
- Not applicable

**Legal aspects**
- Not applicable

**Environmental aspects**
- Not applicable

Facilities that might be interesting for you

<table>
<thead>
<tr>
<th>Title</th>
<th>Institute/company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditorium IRTA</td>
<td>IRTA</td>
</tr>
<tr>
<td>Clean room – Histocell</td>
<td>Noray</td>
</tr>
<tr>
<td>Video observation system for market research and product development tasks - Keki</td>
<td>NAIK EKI</td>
</tr>
</tbody>
</table>

Further Information

**Institutes**
- University of Leeds, UC Santa Barbara, The University of Queensland, NIZO, TI Food and Nutrition, Wageningen UR - FBR

**Companies**
- Unilever
References
