Mastication and swallowing is a complex process

- The flow involves shear and extension
- Squeezing between the tongue and pallet and the entrance to the food pipe gives extension
- Saliva is important for lubrication and dilution, as well as a carrier of enzymes, tastes and aroma
Example 1
Saliva

• Saliva is constantly secreted by several different glands.
• Saliva production increases upon stimulation.

A simple thought is enough...

What is saliva?

• Complex viscoelastic fluid
  – Water ~98%
  – Electrolytes (sodium, potassium, calcium, magnesium, chloride, bicarbonate, phosphate)
  – Mucus (mucopolysaccharides and glycoproteins)
  – Enzymes (mostly α-amylase, lingual lipase, but also several antimicrobial and other minor enzymes)
  – Proline rich proteins
  – Antibacterial compounds
  – Cells
Overview of study

– Comparison of the viscoelastic properties of
  • unstimulated saliva
  • stimulated saliva

– Comparison of the viscoelastic properties of saliva from different glands:
  • human parotoid saliva (HPS)
  • human submandibular-sublingual saliva (HSMSL)

Collection of saliva (HPS)

Glandula PAROTIS

Modified LASHLEY cup
Collection of saliva (HSMSL)

Glandulae
SUBMANDIBULARIS et SUBLINGUALIS

Narrow-gap parallel-plate rheometry

Suitable for
• High shear rates
• Small sample volume

Compensate for the gap error Δh
• Measuring systems not perfectly parallel, concentric or flat
• Δh typically 5-30 μm
• Use Δh to calculate correct viscosity or modulus

Comparison stimulated - unstimulated

\( t = 0 \) minutes

Unstimulated HSMSL has a lower shear modulus and a more viscous behavior compared to stimulated HSMSL.

Comparison stimulated - unstimulated

\( t = 20 \) minutes

Stimulated: higher shear modulus and more elastic behavior

Unstimulated: no significant change
Comparison between stimulated HSMSL and stimulated HPS

HSMSL: higher modulus and more viscoelastic behaviour

Example 2: Food for swallowing disorders
Swallowing disorders = dysphagia

Dysphagia is a common symptom after
- Stroke, dementia, Parkinsons' and other neurological diseases
- Lung disorders
- Different handicaps
- Cancer
- Head and neck injuries
- Age

→ 1.5% of the whole population suffers from dysphagia
→ 40% in the age segment 70+ suffers from dysphagia
→ Malnutrition is common in the elderly population

Current food alternatives for swallowing disorders
A common solution
Worst case solution

A better solution
Food for dysphagic patients divided into classes

The classes are:

- Low viscosity fluids
- High viscosity fluids
- Gel foods
- Solid timbales
- Coarse pâtés

Penetration force of solid foods

[Graph showing penetration force for different types of solid foods, including Gels, Timbals, and Pâtés]
PLS for fluid foods

Viscosity dependence for the sensory attribute "creamy"
Viscosity dependence for the sensory attribute "easy to swallow"

Conclusions

- Our perception of food is based on a short residence time in the mouth → design the product for optimal culinary experience!
- Saliva plays a major role for the experience
- Classes of dysphagia foods can be distinguished by viscometry, penetration tests, sensory analysis and common sense
- Extensional rheology is important for swallowability
Acknowledgements

The Swedish Technical Research Council Vinnova, is acknowledged for financial support.

Coming events

Annual European Rheology Conference
Karlsruhe on April 8-11, 2014
rheology-esr.org

and don't miss
Free membership in the ESR (YEAR-FREE-ESR)

mats.stading@sik.se
+46 10 516 6637