Food Oral Design

Mats Stading [1, 2]

[1] SIK – The Swedish Institute for Food and Biotechnology, Göteborg, Sweden
2 Chalmers University of Technology, Göteborg, Sweden

ABSTRACT

We all eat food and drink liquids several times per day. It is a highly unconscious process rendering the culinary experience and the pleasure of the meal. The mechanisms of the eating and the food processing in the mouth are commonly referred to as *Food Oral Processing*. During the relative short time we keep the food in the mouth we form our opinion of it, and by designing the properties of the food we can therefore optimise the perception to give a desirable culinary experience, which is the essence of *Food Oral Design*.

INTRODUCTION

An important component in the oral processing is saliva, which is involved in taste and aroma transfer, lubrication and bolus formation, and thus strongly contributes to the perception of the food. Before we swallow something we first disintegrate it into smaller particles and mix them with the saliva to form a viscoelastic bolus which we transport to the back of the mouth. Other major functions of saliva are to protect hard and soft oral tissues from wear, dehydration, demineralisation, chemical insult and microbial imbalance. It is particular salivary glycoproteins, such as mucins and proline-rich proteins that have structural features that correlate to the protective function of masticatory lubrication. Mucins are secreted from the submandibular-sublingual salivary glands while the proline-rich glycoproteins emanate from the parotid glands. The saliva from the different glands thus has very different viscoelastic properties.

The actual swallowing is another important component of the oral processing. As healthy individuals we seldom consider it whereas for others it may cause discomfort and even serious health problems. Already over 50 years of age 22% suffer from swallowing disorders, or dysphagia, due to factors such as degenerative diseases, side effects of medication and trauma. These persons must eat texture adjusted foods, and the oral processing is considerably affected. As soon as the bolus hits the pharyngeal arches we automatically swallow.

During the short time it takes to carry out these activities the receptors of various senses in the oral cavity and in the nose are stimulated and we perceive all impressions about what we eat regarding aroma, taste, texture and mouth feel. Ideally this stimulation gives rise to pleasurable food experiences. Normally we do not think about these intricate processes and much of them are even automatic, still they are the basis of how we perceive the food we eat. This means that with detailed knowledge of the eating and swallowing processes we are able to develop food using Food Oral Design.

RESULTS AND DISCUSSION

Saliva is a dilute viscoelastic polymer solution and an important component in Food Oral Processing. It has low shear modulus and is therefore difficult to characterize experimentally. The saliva is also available only in small volumes thus further limiting the experimental techniques available. Davies and Stokes have developed an experimental technique which combines small sample volumes with high strains and strain rates and demonstrated its applicability for saliva viscoelasticity[1, 2]. The method utilizes a parallel plate system with narrow gaps down to 5 µm. The advantages of this new technique as compared to previous measurements using oscillating capillary flow[3, 4], and resonant oscillation[5] are a wide selection of frequencies and a well-defined strain.

The viscoelastic properties of saliva from different glands were characterized using the narrow gap method. Mechanical spectra of stimulated submandibularis and parotis saliva were compared. The submandibularis saliva had higher moduli and longer relaxation times due to higher mucus content than parotis saliva.

Mechanical spectra with moduli in the order of 10^{-2} Pa of saliva were reproducibly determined[2] using a gap of 50 µm.

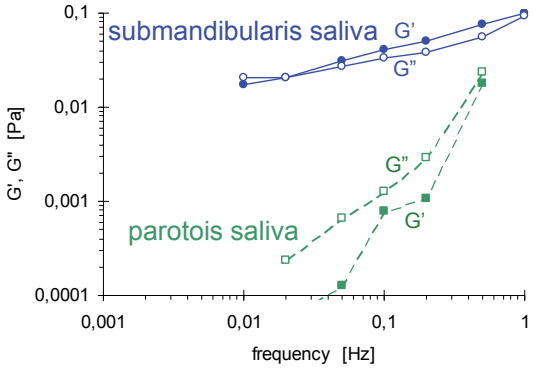

Figure 1. Mechanical spectra of stimulated submandibular saliva (blue, solid lines) and stimulated parotid saliva (green, dashed lines) t=0 (freshly spitted). G' in filled symbols and G" in open symbols[2].

Swallowing is another component of the food oral processing and in a study of commercial processed food products for swallowing disorders, mechanical and rheological methods were used to analytically classify the products that ranged from solid pates to low viscosity soups[6]. The products were also evaluated using sensory analysis and the results were correlated using partial least squares (PLS) analysis. One of the sensory attributes was "easy to swallow" and this attribute showed an interesting correlation with rheology for the fluid products which were different types of soups. The figures 2 and 3 shows a PLS analysis of two of the sensory attributes to shear and extensional viscosity.

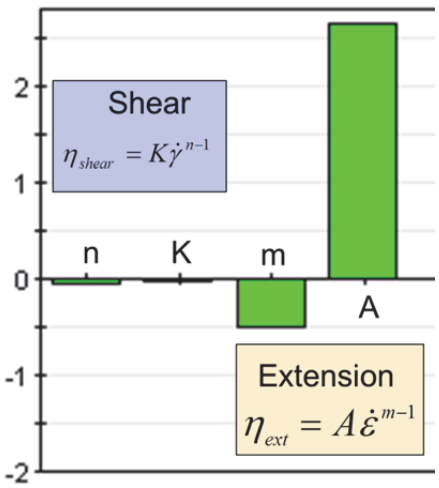

Figure 2. Contribution to the sensory attribute "**easy to swallow**". Extensional properties dominate.

In Fig. 2 the attribute "easy to swallow" is only correlated with the extensional viscosity whereas in Fig. 3 the attribute "creamy" is correlated with both shear and extensional viscosities. These results strongly indicate that extensional rheology is indeed important in the swallowing process. Further evidence of the relative importance of fluid elasticity for ease of swallowing is presented in this volume by Qazi et al.

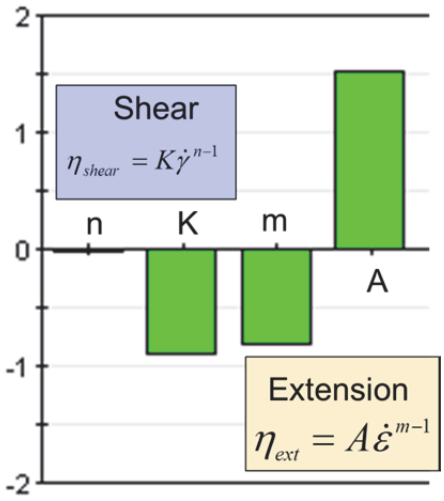

Figure 3. Contribution to the sensory attribute ”**creamy**”. Equal contribution of shear and extension.

CONCLUSIONS

Food Oral Processing depends on many parameters and saliva properties and texture for swallowing are but only two. The exemplified results display the complexity and show that more detailed information on all oral processing parameters are required for successful Food Oral Design

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