Bolus rheology of food for dysphagia management

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ABSTRACT

Healthy individuals apply highly unconscious, but very well coordinated strategies for the oral processing producing easy-to-swallow boluses. The bolus is prepared by chewing and mixing the food with saliva until the particle size is small enough and the bolus has suitable viscoelastic properties to be swallowed.

Bolus rheology was determined for healthy subjects for a set of texture-modified, solid foods regularly given to dysphagia patients. The softest class was gel food, second softest a smooth timbale which both were compared to the corresponding regular, un-modified food.

Rheology showed that texture-modification influence bolus rheology with decreased viscosity and modulus for increased degree of modification.

INTRODUCTION

For an increasing proportion of the population swallowing causes problems. Swallowing disorders, or dysphagia, affects almost half of the population older than 70 whom will require an intake of texture-modified foods progressively softer, smoother and moister depending on the severity of the disorder.

Swedish dysphagia patients are in general given softer solid food with decreased particle size. In the national scale the “timbale” consistency class is the most commonly served to dysphagia patients still able to eat solid food[1, 2]. The following classes are “gel food”, “high viscosity” soups and “low viscosity” soups. Other common systems for consistency classification are the American Dietetic Association guidelines and IDDSI, The International Dysphagia Standardisation Initiative[3], but these place less emphasis on solid foods.

The bolus is a viscoelastic fluid and the rheological properties can be determined in small-amplitude oscillatory shear (SAOS), as well as in shear and extensional flows. Bolus experiments are typically performed by the subject chewing the food until ready-to-swallow and then spits out the bolus. The rheological properties can then be determined and the method has to be carefully designed as the properties change with time and linear region for SAOS is limited[4].

The rheological properties of boluses of a set for texture-modified, solid foods[5] were investigated for healthy subjects. For more information on physiology related properties of these food boluses see Stading, 2021 [6].

MATERIALS AND METHODS

The foods investigated were bread, cheese, tomato and the combination as a sandwich. These foods were tested for the respective texture class: gel, timbale and regular food. The subjects chewed until ready to swallow and the expectorated bolus was immediately measured for complex shear modulus and viscosity, and moisture and saliva content were determined.

RESULTS AND DISCUSSION

The rheological properties of boluses of the different food classes are shown in Fig. 1 for bread, and in Fig. 2 for tomato, for one of the subjects. The timbales are made by thickening a homogeneous puree of the respective food with egg and starch into an omelette-type texture. As the texture and rheological properties to a large extent are determined by the thickening system, also the boluses have similar properties for bread and tomato timbale.

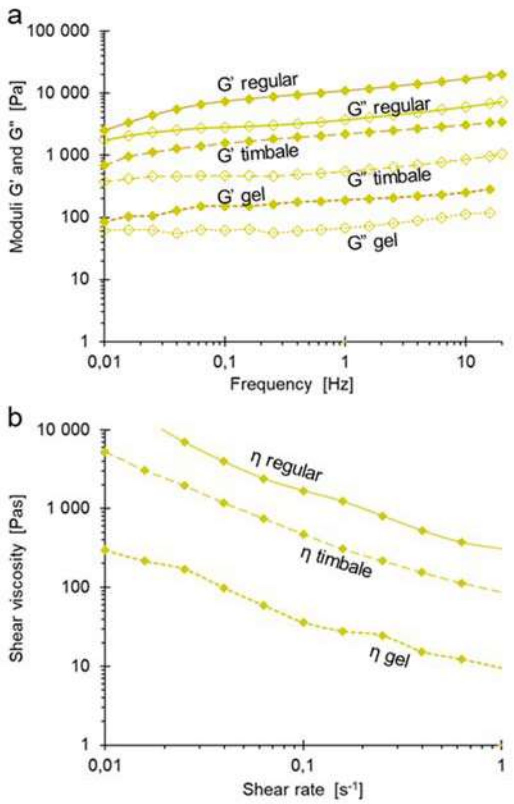

Figure 1. Rheological bolus properties of regular and texture-modified bread, a) mechanical spectrum and b) shear viscosity.

The regular bread and tomato form rheologically quite different boluses. The bread bolus is a concentrated polymer solution whereas the tomato bolus is a dispersion of cell fragments. This is reflected by the bolus flow properties through the viscosity which is considerably higher for the bread bolus.

The mechanically spectra of regular bread and tomato are more similar reflecting consistent bolus structure required for smooth swallowing. The human body regulates chewing and saliva excretion to form a bolus with suitable consistence for swallowing. There are several mechanisms involved and the exact threshold for swallowing is not known.

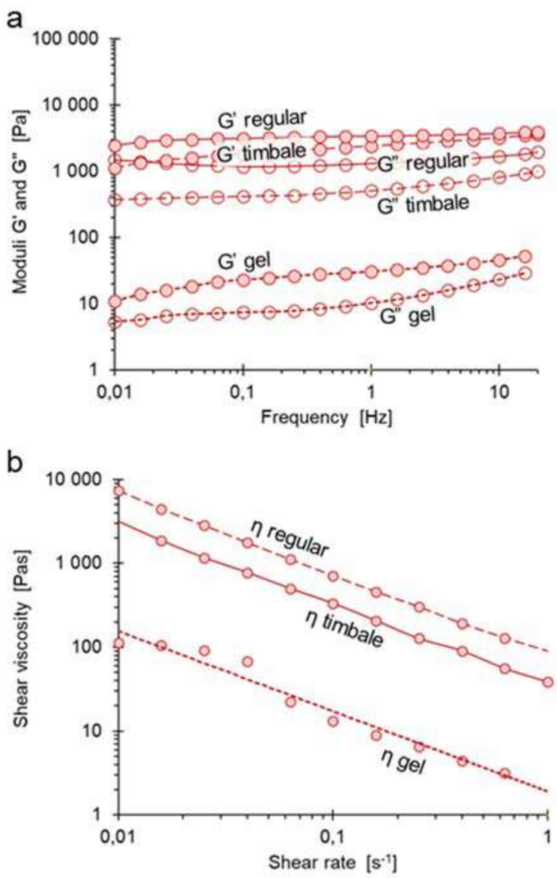

Figure 2. Rheological bolus properties of regular and texture-modified tomato, a) mechanical spectrum and b) shear viscosity.

The gel food boluses are also different as the gelled bread is prepared by soaking regular bread in a thickener solution, whereas the tomato gel is prepared by gelling strained tomatoes with gelatine. The different structure is again reflected by the mechanical spectra whereas bolus viscosities are more similar.

CONCLUSIONS

The study overall showed that texture-modification influence bolus rheology with decreased viscosity and modulus for increased degree of modification[6].

Bolus rheology rather than food texture determines if a food is safe to swallow and the results show that the intended texture-modification is reflected in the flow properties of the respective boluses.

ACKNOWLEDGMENTS

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