Unraveling mouthfeel

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Summary

A recent (2019) US report indicates that 85 % of new food-packaged products fail within two years from the market. It is believed that one of the main reasons behind this fact is the mismatch between consumers' expectations or preferences and the sensorial characteristics of new products. Therefore, understanding consumers' preferences and matching them with the desired sensorial properties is crucial for a successful strategy of new product design.

However, to understand and predict the sensorial properties of food products, many hurdles need to be taken. First, a well-accepted and defined lexicon among consumers, marketers and food researchers/designers needs to be established. Additionally, objective methods for sensorial characteristics evaluation must be further developed. Until now sensory evaluation is mainly conducted by subjective methods that are expensive, time-consuming and less reliable than the objective methods. However, developing and establishing objective methods has many challenges. The researchers need to gain a good understanding of the origin and different characteristics that arouse oral sensations. Furthermore, the development of chemical or physical analytical protocols needs to be established based on the related characteristics of oral sensations. Lastly, chemometric approaches are essential for the interpretation of potential patterns between chemical analysis and sensory attributes.

This thesis deals with uncovering the important characteristics of mouthfeel sensations that occur during consumption. Therefore, chapter 1 describes in detail the importance of mouthfeel sensations and disguising flavor, taste, mouthfeel and aroma. The oral processing and the importance of physical characteristics and changes which occur in the mouth during consumption are highlighted as well.

The current confusion and lack of a co-existing mouthfeel terminology in the literature are extensively reviewed in chapter 2. Additionally, an empirical mouthfeel model is introduced in the same chapter. The mouthfeel model is summarized by three axes, coating, contracting and drying. Where coating and drying axes are the subcategories of the tactile sensations when contracting summarizes the chemesthetic sensations. This simplified model provides classification among different food products based on the three axes.

To gain new insights into oral sensations, and more specifically into tactile sensations, chapter 3 highlights the importance of saliva involvement in oral sensations. As a bio fluent, saliva possesses unique physical properties due to salivary proteins. Therefore, this chapter reviews the salivary properties which are responsible for the lubrication properties, and the interaction of food components with the salivary proteins which leads to changes in the salivary film integrity and results in the arouse of tactile sensations. The properties of salivary lubrication and the interactions that occur during consumption. This is related to changes in the saliva composition of elderly people or as a result the use of pharmaceuticals. As salivary lubrication is intimately connected to the consumption and liking of foods and beverages these insights are likely to be useful in helping people to eat well. Research in this field merits further elaboration.

In chapter 4, the effect of molecular weight, pH and the addition of mannoprotein on the lubrication behavior of saliva was investigated. Human salivary proteins interacted with model solutions, containing tannic acid and gallic acid, under different conditions. The friction of the system was measured by soft tribology and hydrodynamic diameter by zetasizer. The results

of this study suggested that higher molecular weight and lower pH decreased the lubrication properties of saliva. Additionally, the presence of mannoproteins in gallic acid solutions resulted in less binding of the gallic acid into salivary proteins. A high correlation was observed between aggregate formation and friction which lead to the conclusion that aggregate salivary proteins could not provide their lubrication properties.

Chapter 5 describes a study about the effect of different phenols on salivary lubrication behavior. Four phenolic components were selected based on the difference between hydroxyl and galloyl groups. The lubrication properties were measured by soft tribology, aggregate formation of specific salivary proteins was investigated using SDS-page, while the wetting properties were recorded via tensiometer. The extra hydroxyl and galloyl groups decreased the salivary lubrication. The aggregate formation between phenols and salivary proteins lowers saliva wetting properties which can explain the lower lubrication properties. Finally, the glycosylated proline-rich proteins showed the highest association regarding lubrication loss.

The effect of cations on salivary lubrication was investigated in chapter 6. Cationic valences, concentrations and ionic strength were examined for their impact on the lubrication behavior of saliva. Additionally, the interactions among phenol, cation and salivary proteins were studied as well. Friction, hydrodynamic diameter, viscosity, and reduction of protein density were used for getting insights into the interactions between salivary proteins and cations. Trivalent salts were able to cross-link mucins and form aggregates which lead to lubrication loss. KCl at 150 mM ionic strength value was able to provide extra lubrication via hydration. Epigallocatechin gallate interacted with Fe^{3+} via chelating interactions which led to lower binding of Fe^{3+} to mucins and reduced the induced friction by Fe^{3}.

Commercial beers were evaluated based on mouthfeel sensorial and chemical characteristics in chapter 7. Chemometric tools were applied to discover potential patterns in the data. Panelists were able to classify the sensorial attributes into three main sensorial categories. The three categories are associated with the mouthfeel model axes. A clear correlation was observed between sensory and chemical data. Total polyphenol content, bitterness units, pH and total iso-α-acids were correlated with bitterness and drying. Carbon dioxide is correlated with carbonation, while ethanol is associated with burning. Last, pH and titratable acidity correlated with contracting. These outcomes indicate the mouthfeel model implication and the potential of objectively measuring mouthfeel.