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The effect of saliva composition on texture perception of semi-solids

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ABSTRACT

Saliva is expected to be of significance for the perception of food stimuli in the mouth. Mixing the food with saliva, including breakdown and dilution, is considered to be of large importance for semi-solids as these products are masticated without chewing. It is known that there are large variations in composition of saliva originating from different glands and different subjects. In this study we investigated how variations in salivary characteristics affect sensory perception. Eighteen trained subjects participated in the study. Saliva was collected at rest and during three types of stimulation (odour, parafilm chewing and citric acid), and flow rates were determined. The collected saliva was analyzed for protein concentration, buffer capacity, mucin level and α-amylase activity. The salivary components measured in this study varied considerably among subjects, but also within subjects as a result of different means of stimulation. Variations in salivary components were correlated with sensory perception of a number of flavour, mouth feel and after feel attributes in the semi-solids mayonnaise and custard dessert. Total protein concentration and α-amylase activity were observed to correlate most strongly with texture perception.

1. Introduction

Saliva is expected to be of importance for the perception of food stimuli in the mouth. It can play a role by initial breakdown of food,[1,2] by affecting flavour release,[3] dilution of flavours and tastes,[4] precipitation of proteins by tannins, e.g. resulting in a sensation of astringency,[5,6] lubrication of the oral tissue,[7] facilitating manipulation of food in the oral cavity and swallowing, and by transport of taste compounds to the taste buds. These examples indicate the value of saliva for the appreciation and acceptance of food. Saliva consists for more than 99% of water and contains a large number of organic and inorganic constituents.[8] Saliva is therefore considered important and it seems plausible that both the volume and composition of saliva present in the mouth while eating are of importance. A previous study has shown results contradicting the importance of volume of saliva.[9] In that study saliva flow rate of healthy subjects failed to show any correlation with sensory sensations of vanilla custard dessert. A possible explanation for this is that the subjects are used to their own volumes of saliva and their ratings are compared with an internal standard. The continuation of that study was

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to add extra saliva to increase the normal level that the subjects were used to.[1] In that study different components of saliva were compared: in addition to saliva, water and an α-amylase solution were added to food immediately prior to ingestion. The results indicate that many effects of saliva on flavour and texture sensations are attributed to dilution, since the three fluids produced similar results. For attributes concerned with thickness and melting of the product, however, saliva and α-amylase were more potent. Addition of saliva produced the strongest sensation for melting, indicating that saliva exhibits additional effects on the product. Obviously there are components in saliva, other than water, that affect the food while in the mouth. Of the numerous possible compounds, we made a selection of three to analyze, all hypothesized to play a role either in oral breakdown or perception of food: proteins, mucins, and α-amylase. In addition, buffer capacity of the saliva was measured, as it is thought to be of importance for taste perception and pH dependent reactions. Proteins play a possible role in taste chemoreception and in the perception of astringency, viscosity, and other mouth feel attributes.[10] The mucin analyzed in this study is the MUC5B, also known as MG1. MUC5B is a very large mucosal glycoprotein present in a mucous layer that covers and protects the oral cavity.[11,12] The mucins exhibit diverse functions in saliva, among others protection against pathogens [13] and dehydration,[7,14] and perhaps more important in this study, lubrication.[15,16] α-Amylase initiates starch digestion in the mouth. By cutting the long carbohydrate strands at the alpha (1–4) binding between glucose residues, the starch is reduced in its ability to bind water and the result is a lower viscosity of the product. Sensorially, α-amylase is shown to influence the sensation of melting in semi-solids.[1] Saliva acts as a buffering system,[17] affecting the degree to which we perceive sourness.[18] The buffering effect of saliva is attributed largely to bicarbonate/carbonate ions, and to a lesser extent to phosphate-ions and proteins present in saliva,[19] neutralizing acids ingested or produced by micro-organisms in the mouth.

Semi-solids are a group of products masticated without chewing. Therefore mixing with saliva, including structure breakdown and dilution is considered to be of relatively large importance in mastication of these products. Consequently, the components of saliva are suggested to play a considerable role in mastication and perception. It is known that there are large variations in composition of saliva originating from different glands, and different subjects,[20] but it is not known how these variations in salivary characteristics affect sensory ratings.

The aim of this study was to investigate: firstly, the variation of salivary components after different stimulations; and secondly, the influence of salivary composition on flavour and texture sensations in custard and mayonnaise.

2. Material and methods

2.1. Subjects

Eighteen healthy adults (6 males and 12 females, with an average age of 24.5 years) participated in the study. The subjects were selected on the basis of a well-functioning olfaction and taste perception, and had received extensive training in the use of sensory odour, flavour, texture, and after feel attributes for semi-solids. Each person gave informed consent and was paid for their participation.

2.2. Saliva

2.2.1. Collection

Whole saliva flow was measured during rest and after three types of stimuli: (1) after stimulation by odour (AH vanilla vla, AH, The Netherlands), (2) during mechanical stimulation (chewing Parafilm®, American National Can, Greenwich, CT, US), and (3) during chemical stimulation (citric acid monohydrate, Merck, Darmstadt, Germany), as described elsewhere.[9] Saliva was collected on four separate occasions, where only one type of stimulus was presented per occasion. To avoid circadian variations, each subject was always tested on the same time of the day. All four types of saliva were collected in the following way: during 5-min periods saliva was spat at 30 s intervals into pre-weighted containers and flow rates (ml/min) were calculated. The three stimuli were applied as follows: (1) custard odour was administered by holding a bowl of custard under the subjects' nose during 5 min. (2) Parafilm was chewed during the whole collection period. (3) Three droplets of 4% citric acid were applied to the tongue at 30 s intervals. After collection saliva was centrifuged at 10,000 rpm for 5 min to remove buccal cells and oral micro-organisms. The clear supernatant was stored at −20 °C until further analysis.

2.2.2. Analysis of saliva

Total salivary protein was measured by the bicinchoninic acid protein assay[21] with bovine serum albumin as standard. This assay is described in detail by Bosch et al.[22]

Mucin concentration was determined by ELISA as described by Veerman et al.[23] The mucin levels were compared to standard saliva, a mixture of saliva from a large number of subjects and stimulations, e.g., a result of 200 means that the mucin level in that sample is 200% of the standard saliva mixture.

Buffer capacity was measured by a modified version of Ericsson's method.[24] Two hundred microliters of saliva was mixed with 600 μl HCl (0.0033 M). pH measurements (PHM 240 Labmeter, Radiometer, Copenhagen, DK) started immediately after mixing and read when stable or after 60 s, whichever occurred first.

α-Amylase activity was assayed by EnzChek Amylase kit (E-11954, Molecular Probes, Leiden, The Netherlands, http://www.probes.com/) according to the protocol. The kit contains a starch derivative that is labelled with a dye to such a degree that fluorescence is quenched. α-Amylase catalysed hydrolysis relieves this quenching, yielding brightly fluorescent dye-labelled fragments. The accompanying increase in fluorescence is proportional to α-amylase activity and was monitored with a fluorescence microplate reader (Fluostar, Galaxy, BMG laboratories, Offenburg, Germany). A number of changes to the protocol were made as described below: Human salivary α-amylase (art. Nr. 10092, Fluka, Buchs, Germany) was used as control enzyme in the following concentrations: 0.5–1.0–1.5–2.0–2.5–3.0–3.5–4.0 U/ml to produce a calibration curve. 0.1% BSA was added to the provided