General introduction and aim of this thesis
Throughout history, humans have sought various aids to maintain oral health. In ancient times, by rinsing their mouth with vinegar, later by chewing on the end of a twig of the *Salvadora persica* tree, which eventually has led to the modern day toothbrush. Today's society can choose a vast array of toothbrushes, dentifrices, mouthrinses, toothpicks and dental floss, which are continuously developing to serve more specific needs (1). Besides the traditional oral health care products, also chewing gum has developed into an oral care product.

Undoubtedly, oral health has advanced tremendously over the last decades, reflected in a decrease in the number of total denture wearers in The Netherlands from 32% in 1981 to 12% in 2009 (2). Nevertheless, prevalence of oral diseases is still one of the most important diseases present in daily life, as dental caries is one of the most non-communicable diseases among children worldwide and affecting the vast majority of adults in industrialized countries (3,4). Only 16% of all young adults in the Netherlands have a perfect dentition without any restorations (5) and approximately 12% of the Dutch population receives a dental filling every year (6). Numbers on the epidemiology of gingivitis vary greatly but estimates are that more than 50% of all adults experience gingivitis from which roughly 10% advances to severe periodontitis (7–9). These figures indicate the difficulty of maintaining oral health and are illustrative for the necessity of continuous improvement of oral health care products.

Causative to most oral diseases, including caries, gingivitis and periodontitis, is the formation of oral biofilm. Planktonic bacteria in saliva adhere to the salivary conditioning film on the tooth surface to form a biofilm; a complex structure of multiple bacterial species, protected by a matrix of extracellular polymeric substances from environmental forces and antimicrobials. If the oral biofilm is not mechanically removed, the composition of the biofilm changes which is the onset of diseases (10–12). In the case of caries, specific bacteria in the biofilm ferment environmental sugars into acids, causing softening of the enamel. Normally this is counteracted by minerals in saliva which recover hardness of the enamel, however when this balance is lost the tooth surface is prone to cavities (13). As gingivitis is concerned, specific pathogenic bacteria in biofilm in the gingival margin and in between teeth excrete products that cause a signaling cascade in the gingival tissue of the host, resulting in an inflammatory response. If left untreated, the inflammation may advance to periodontitis, affecting the bone around the teeth which can eventually lead to tooth loss(14).

Since the 1970s, chewing gum developed from a candy into an oral care product. Replacement of conventional sugars by artificial sweeteners, which cannot be fermented into acids by oral bacteria, together with the stimulation of saliva during chewing made
chewing gum an established oral care product (15). Currently, dictated by the urge for continuous product development, various active ingredients are incorporated in chewing gum to chemically influence the oral biofilm, for instance by reducing the number of bacteria in saliva or preventing bacterial adhesion to the tooth surface, all aiming to enhance the current oral health benefits (16–18).

**Aims of this thesis**

The general aim of this thesis is to explore new possibilities to further develop the oral health benefits of chewing gum. To this end, we first evaluated the current oral health benefits of chewing gum, emphasizing the effects of active ingredients on biofilm formation. The effects of two active ingredients in chewing gum on oral biofilm after 4 weeks of use and the effects on the mouthfeel perception in relation to tooth surface properties was investigated in an *in vivo* study. Next, we looked into the importance of adhesion forces of bacteria in the oral cavity and its role in the eventual bacterial composition of the biofilm. Subsequently, the possibilities of using a piece of chewing gum to trap oral bacteria and to remove them from the oral cavity was investigated both *in vitro* and *in vivo*. Finally, we explore the first step towards the development of an oral care agent that targets specific bacteria within the oral cavity.
References


