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Review Article

A Chemical-Mechanical Tongue Cleaning Method: An Approach to Control Halitosis and to Remove the Invisible Tongue Biofilm, A Possible Cause of Persistent Taste Disorder

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Abstract

Tongue coating or tongue biofilm is the main and most common cause of halitosis, as shown by numerous studies. There are four types of lingual papillae, three of which contain taste buds (vallate, fungiform and foliate papillae). The filiform papillae are the most numerous and although they do not have taste cells, they surround the fungiform papillae and are in contact with the vallate and foliate papillae, which have taste buds. The anatomy of a single filiform papilla shows that it is not a simple bud coming out of the surface of the tongue, but a group of individual filaments in within the tongue biofilm can accumulate. In case of shear forces exerted on the papillae (i.e., the use of a tongue scraping), the sturdy papillae bend slightly and protect the then embedded biofilm remaining in the interstitial volume. Tongue coating may thus physically limit tastants' access to taste pores and thus prevents their binding to taste receptors. A chemical-mechanical tongue cleaning technique (DC technique) can reach this biofilm with a better efficiency than the traditional methods to clean the tongue, such as the use of a tongue scraper or a toothbrush. DC technique removed 67,5% more coating than the tongue scraper and 148% more than the toothbrush. Further research should compare these methods concerning taste disorders.

Keywords: Taste disorders; Halitosis; Dysgeusia; Biofilms; Tongue.

Introduction

It is well known that tongue coating or tongue biofilm is the main and most common cause of halitosis, as shown by numerous studies [1-5], and its formation is related to the anatomy of the tongue. The dorsal surface of the tongue may be colonized by large amounts of bacteria, mostly in the presence of fissures, crypts and high mucosal papillae. These anatomical niches may create an environment where microorganisms are well-protected from the flushing action of the saliva and where oxygen levels are low, thus promoting the development of

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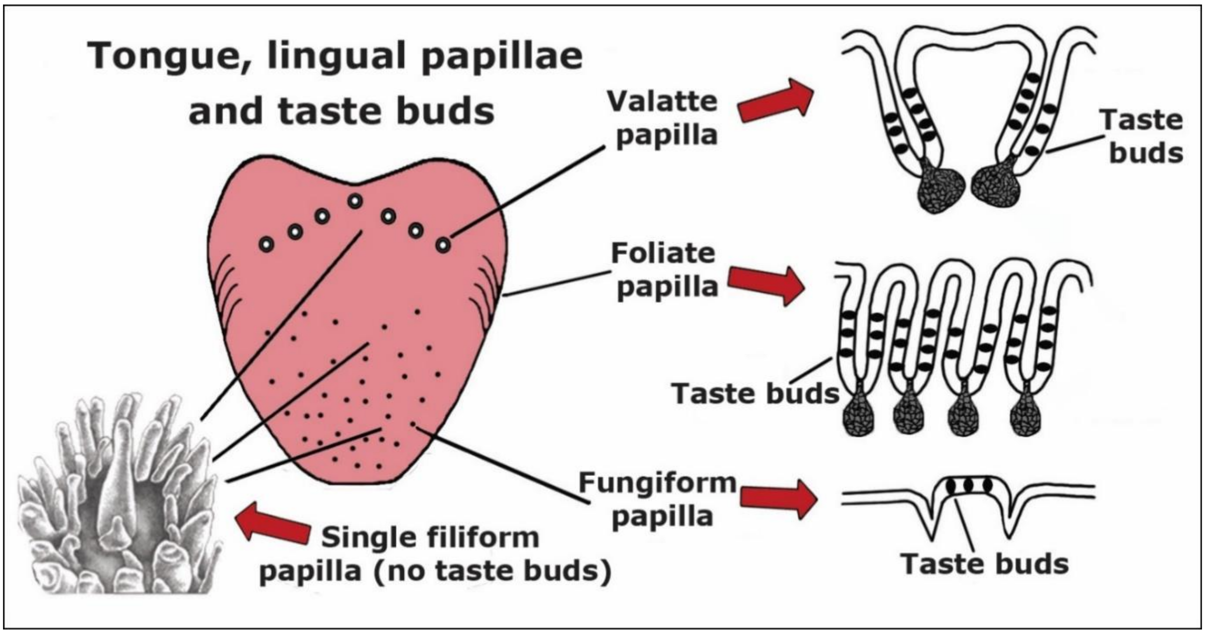
anaerobic microbiota, that may produce volatile sulphur compounds (VSC) [6,7]. The papillary structure of the dorsum represents a unique ecological niche in the oral cavity, offering a large surface area that favors the accumulation of oral debris and microorganisms. Moreover, its location as a crossroad between the oral cavity and the pharynges provides access to many different types of nutrients, products and bacteria [6].

Lingual papillae X Tongue coating

There are four types of lingual papillae, three of which contain taste buds (vallate, fungiform and foliate papillae). The filiform papillae are the most numerous and although they do not have taste cells, they surround the fungiform papillae and are in contact with the vallate and foliate papillae, which have taste buds [8]. Apparently, each lingual papilla appears to be a single structure, lined up side by side on the tongue surface, which Maeda [9] described as consisting of papillae oriented perpendicular to the tongue plane. However, Kobayashi et al. [8] examined the anatomy of a single filiform papilla by electron microscopy, and it was found that each papilla itself is not a simple bud coming out of the surface of the tongue, but a group of individual filaments (Figure 1).

Figure 1: Tongue, lingual papillae, and taste buds, where vallate, fungiform and foliate papillae have taste buds and filiform has not, being a group of filaments.



In this way, a single filiform papilla consists of a primary base in the form of a column, numerous secondary thin protrusions in the form of rods in its external limit and a few central protrusions (Figure 2a). The tongue biofilm can accumulate within the filaments in different degrees (Figures 2b, 2c and 2d), covering the whole papilla in case of a thick biofilm (Figures 2d, 3a and 3c).

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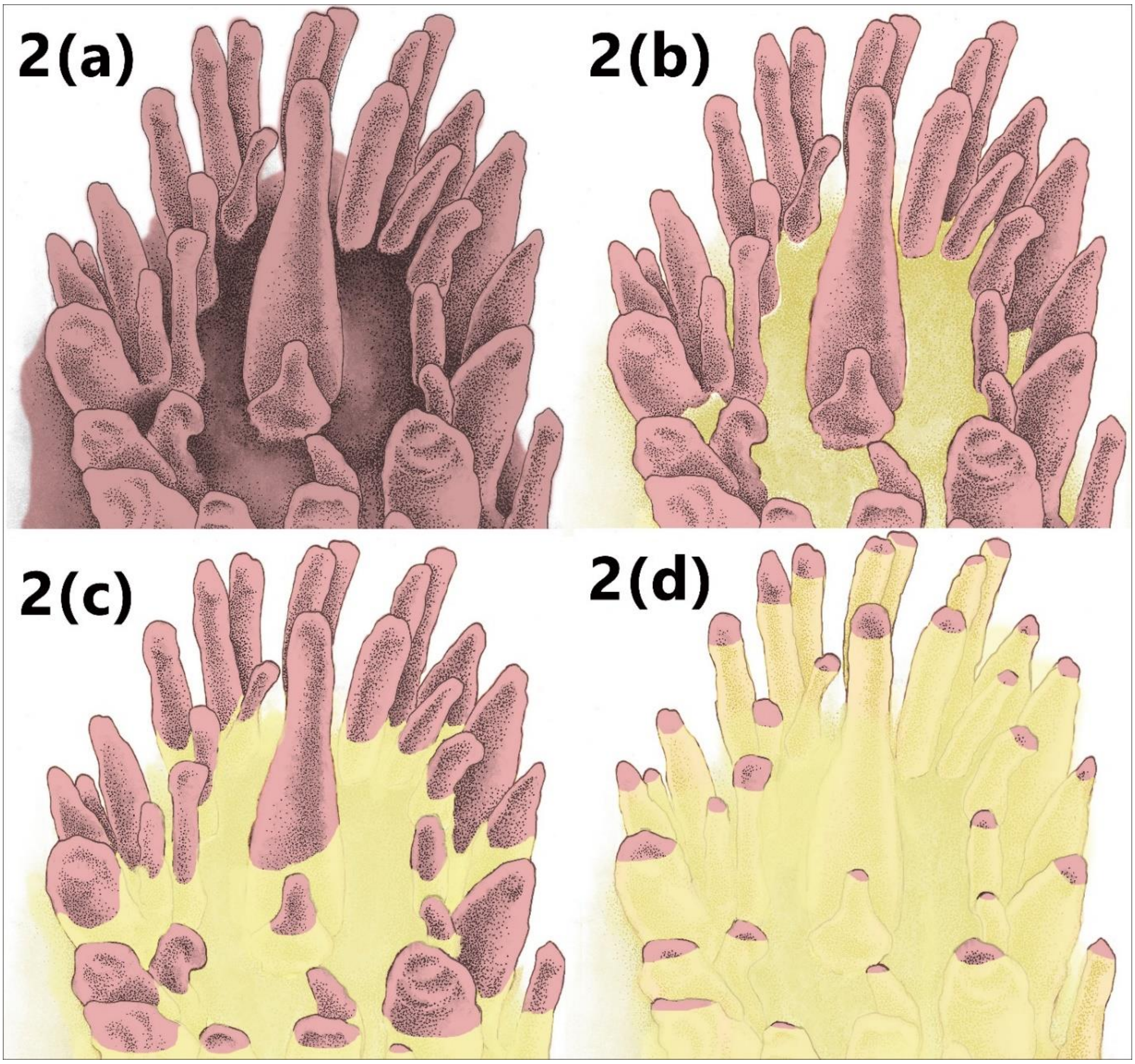
Figure 2: Drawings representing: (a) A single filiform papilla under electron microscopy, with a group of individual filaments; (b, c and d) Filiform papilla with the presence of different amounts of biofilm.



Hess et al. [10] proposed that in case of shear forces exerted on the papillae (i.e., the use of a tongue scraping), the sturdy papillae bend slightly and protect the then embedded biofilm remaining in the interstitial volume (Figure 3b). But, considering that according to Kobayashi et al. [8] a single papilla is a group of individual filaments, the remaining biofilm would be in the spaces among the papillae and the filaments. In other words, there would be a remaining tongue biofilm in the spaces inter and intra papillae (Figure 3d) [11].

In the same way that the tongue coating is called visible tongue biofilm, the remaining biofilm among and within the filiform papillae, after using a tongue scraper, can be called invisible tongue biofilm (Figure 3d). This is an unprecedented terminology, according to a search made in different database, such as Pubmed, Embase, Scopus, Lilacs and Google Scholar.

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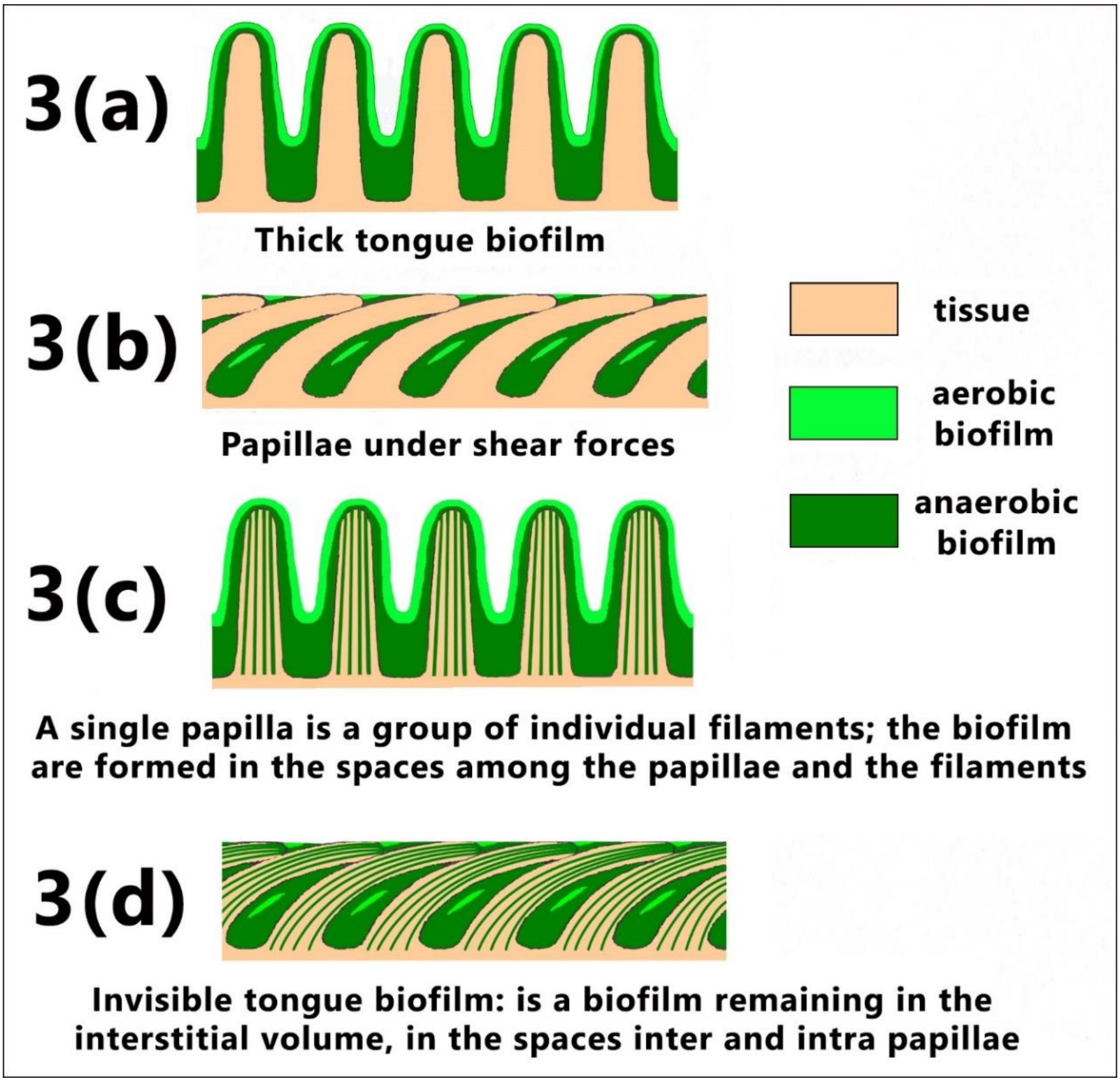
Figure 3: Drawings representing: (a) Papillae filiform with a thick biofilm; (b) In the case of the use of a tongue scraper, the sturdy papillae bend slightly, and then protect the embedded biofilm remaining in the interstitial volume; (c) A single papilla is a group of individual filaments; so the biofilm are formed in the spaces among the papillae and the filaments; (d) Invisible tongue biofilm: the papillae and the filaments bend slightly after scraping the tongue, and protect the embedded biofilm remaining in the spaces inter and intra papillae.



The search included all articles published on or before April 27, 2021.

Tongue coating x Taste disorders

Oral interventions have been proposed for taste improvement. Four studies focused on the effects of oral hygiene on taste acuity of healthy people [4,12-14]. As tastants need to diffuse through these biological coatings to reach lingual taste pores and interact with taste receptors, tongue coating may thus physically limit tastants' access to taste pores and thus prevents their binding to taste receptors [15]. Tongue cleaning would therefore act in facilitating the access of tastants to taste pores and also decreasing or suppressing

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any bacterial taste stimulation. Timmesfeld et al. [14], 2021, showed that mechanical tongue cleaning might be a useful option to improve taste sensation, highlighting that tongue biofilm could be a cause of persistent taste disorders in heathy subjects. Finally, in a taste disorder's management systematic review, Braud & Boucher, 2020, suggests that as long as tongue coating is correlated with volatile sulfur compounds (methylmercaptan and hydrogen sulfide) originating from the bacterial metabolism of the amino acids of debris and desquamated cells lining the oral mucosae [16], tongue cleaning may suppress oral malodor and thus improve chemosensory perception.

Tongue cleaning methods

The two most used methods for tongue cleaning are the use of a toothbrush and a tongue scraper. The tongue scraper is a more effective method than the toothbrush, as it reduced the VSC in 75%, while the toothbrush only achieved a 45% reduction [17]. But, according to Hess et al. [10], scraping the tongue may leave a remaining biofilm, that could cause a taste disorder (Figures 3b and 3d).

For a better tongue coating removal, a chemical-mechanical tongue cleaning technique was developed [18], using a tongue cleaning with bristles in one side of the active point and a tongue scraper on the other side. It is used with a tongue cleaning spray solution, that has three different antimicrobial agents in low concentration (hydrogen peroxide, sodium perborate and cetylpyridinium chloride). With the help of gentle back-and-forth movements using the tongue cleaner bristles side, the tongue cleaning solution can reach and release the remaining biofilm between and within the lingual papillae. Then, after making these movements for at least 30 seconds, time normally enough to release the biofilm, the tongue scraper side will easily remove it, without needing to put any pressure while scraping the tongue, because all the tongue coating is already detached.

The use of these two appliances together (Figure 4) was established into a step-by-step method, including a procedure to minimize the gag reflex and not to hurt the vallate papillae, called DC Technique (Técnica Duarte da Conceição). There are two important factors that can complicate achieving good results with tongue coating control: excessive nausea or gag reflex, when the patient cleans the tongue, and ankiloglossia. In this sense, DC technique has important advices to get around those difficulties [11].

In a research comparing the efficacy of tongue coating removal of the DC technique to a tongue scraper and a toothbrush, the DC technique removed in grams 120% more biofilm than the toothbrush and 37,5% than the tongue scraper [19,20].

But, if the grade of visible biofilm was considered in each day the cleaning with the different methods were performed, the DC technique removed 67,5% more coating than the tongue scraper and 148% more than the toothbrush [19,20].

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Figure 4: Halitus® tongue cleaning spray solution and Halitus® tongue cleaning, with bristles in one side of the active point (front) and a tongue scraper on the other side (back).

As an extra help to reduce tongue biofilm neoformation, Halitus® mouthwash can be used, as it reduces tongue coating and tonsilloliths formation, and VSC concentration (Figure 5), according to a double-blind placebo-controlled study, carried out with 50 volunteers [21].

Taken together, the DC technique is a possible approach to control halitosis and to reduce taste disorders caused by invisible tongue biofilm, as it removes more tongue biofilm than the toothbrush or the tongue scraper.

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Figure 5: Halitus® mouthwash, that reduces tongue coating and tonsilloliths neoformation, and VSC concentration.

Moreover, Halitus® mouthwash can help to maintain taste ability, as it reduces tongue coating neoformation. Further research should compare these methods concerning taste disorders.

Conflict of interest

The main author declares a conflict of interest as he developed Halitus® Products, to help treating halitosis, tonsilloliths, dry mouth and taste disorders.

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