

# Tongue Hygiene and Its Significance in the Control of Halitosis

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## ABSTRACT

Halitosis or oral malodor refers to the foul smell emanating from the oral cavity. This unpleasant condition frequently poses a problem in social communication and is also a common psychological concern. In the majority of cases, the origin of halitosis is related to an oral cause. Tongue coating is one of the important etiological factors of halitosis. Tongue is a potential reservoir of microorganisms which are responsible for the production of malodorous volatile sulfur compounds. A strong correlation has been established between tongue coating and halitosis. Tongue cleaning, on a regular basis, controls halitosis by removal of tongue coating and/or by reducing putrefaction by bacteria. Different approaches, mechanical as well as chemical, have been employed in the prevention and treatment of halitosis derived from the tongue coating. This article highlights the potential need for concentrating on tongue hygiene as a part of daily routine.

**Keywords:** Halitosis, Malodor, Tongue coating, Tongue cleaning, Tongue hygiene.

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## INTRODUCTION

Halitosis or oral malodor refers to an oral health condition characterized by consistently emanating odorous breath.<sup>1</sup> It can affect individuals of all ages without any gender predilection.<sup>2</sup> Because of its personal nature, halitosis can cause social embarrassment, emotional and psychological distress leading to a lack of self-esteem, self-image and self-confidence.<sup>3</sup>

Prevalence of halitosis in the general population ranges from 22% to more than 50%. In addition, approximately 50% of adults and elderly individuals emit socially unacceptable breath, related to physiological causes upon arising in the morning.<sup>1</sup>

Halitosis can be caused by a number of etiological factors, both intraoral and extraoral. More than 90% of the cases originate in the oral cavity and can be attributed to deep carious lesions, periodontal diseases, oral infections, peri-implant disease, pericoronitis, mucosal ulceration, impacted food or debris, factors causing decreased salivary flow rate and mainly tongue coating.<sup>1</sup> It is therefore clear that the dental profession needs to take responsibility in managing halitosis.<sup>4</sup>

It is a widely accepted fact that halitosis is the outcome of release of volatile sulfur compounds (VSCs) which includes hydrogen sulfide, methyl mercaptan and dimethyl sulfide. These compounds result from the proteolytic degradation of sulfur-containing substrates by predominant anaerobic gram-negative bacteria.<sup>3,5</sup> Other non-sulfur containing compounds that may also contribute to halitosis include diamines, such as cadaverine and putrescine, acetone and acetaldehyde.<sup>6</sup>

The tongue is the major site of oral malodor production, while periodontal disease and other factors seem to be only a fraction of the overall problem.<sup>7</sup> Liu et al, when examining the Chinese population for halitosis, demonstrated that the amount of tongue coating played the most important role in increasing concentration of VSCs in mouth air, followed by periodontal status and plaque index scores.<sup>8</sup> According to Tonzetich and Ng, the tongue and not the dental plaque is the principal source of halitosis.<sup>9</sup>

Many microorganisms have been found colonizing the dorsum of the tongue. It has been suggested that tonsils, teeth and gingiva can be colonized by tongue bacteria, which originate, especially from the posterior region.<sup>10</sup> The structure of the tongue favors a unique and complex bacterial biofilm.<sup>11</sup>

Tongue hygiene is being practiced routinely worldwide for centuries.<sup>12</sup> However, in the last decades, not many research studies on tongue have been published, may be because of the need to concentrate on the protection and treatment of the hard dental tissues and their supporting structures. Fortunately, in the recent years, with the increasing scientific knowledge of tongue biofilm, there has been a growing interest in the study of the tongue hygiene and its relationship with halitosis, including therapeutic implications aimed at the tongue biofilm.<sup>11</sup>

## TONGUE AS AN ECOLOGICAL NICHE

Tongue is one of the most important anatomic structures in the oral cavity. The location of the tongue as a crossroad between the oral cavity and the pharynx provides access to many different types of nutrients, products and bacteria.<sup>11</sup>

The dorsum of the tongue represents a unique ecological niche for microorganisms in the oral cavity. The dorsal tongue mucosa, with an area of 25 m<sup>2</sup> shows a very irregular surface topography. Presence of a number of oval cryptolymphatic units on the posterior part contributes to

the rough surface. The anterior part is even rougher due to the high number of papillae (the filiform papillae with a core of 0.5 mm length, a central crater and uplifted borders, the fungiform papillae with a length of 0.5 to 0.8 mm, the foliate papillae located at the edge of the tongue separated by deep folds, and the vallate papillae 1 mm in height and 2 to 3 mm diameter.<sup>13</sup> Morphological surface irregularities include fissures, grooves and depapillated areas that may serve as retention areas for harbouring microorganisms. The frequency of fissures on the dorsum of the tongue in a group of healthy, gingivitis and periodontitis patients has been reported as being moderate. The presence of deep fissures has been related to twice the total counts of bacteria and to sufficiently higher mouth odor and tongue odor scores. Thus, the surface roughness of the tongue presents an ideal niche to promoting and favoring bacterial adhesion and growth and also sheltering from cleaning actions.<sup>11,14</sup>

### MICROFLORA OF THE TONGUE

A large number of microorganisms have been found colonising the tongue. Tongue microflora is generally characterized by a wide variability and diversity, with high proportions of anaerobic bacteria. Tongue serves as a potential reservoir for different periodontopathic microorganisms.<sup>11</sup>

Anaerobic species in the tongue microflora were first identified by Gordon and Gibbons in the year 1966. Since then, many microorganisms closely associated with periodontitis and caries have been evaluated in relation to their presence on the tongue.<sup>10,11</sup>

It has been generally observed that the microorganisms of the tongue influence the flora of the entire oral cavity. According to Krasse, a large proportion of bacteria including *Streptococcus salivarius*, which are present in saliva emanate from the tongue.<sup>10</sup> Van der Velden et al concluded that in particular, the mucosa of tongue and tonsils may harbor periodontopathic microorganisms and may possibly function as a nidus for these bacteria.<sup>15</sup>

*Porphyromonas gingivalis* (*P. gingivalis*), which is usually absent or present in low numbers in periodontally healthy individuals, can be detected on the dorsum of the tongue along with saliva, tonsils, buccal mucosa, gingiva and other mucous membranes in periodontitis patients. In a study by Timmerman et al, *P. gingivalis* was present in 63% of samples from the tongue, in subjects with or without attachment loss.<sup>16</sup>

*Prevotella intermedia* has been detected in approximately 80% of the tongue samples in a population without clinical attachment loss and has been recovered in relatively high numbers from the majority of tongues and tonsils

of patients with periodontal disease.<sup>17,18</sup> *Actinobacillus actinomycetemcomitans* has been recovered from subgingival samples and the tongue in patients with generalized juvenile periodontitis and those with adult periodontitis.<sup>18</sup> Capnocytophaga are more frequently recovered from the tongues of non-diseased persons compared to periodontal patients.<sup>10</sup> *Prevotella melaninogenica*, *P. loescheii*, *P. denticola*, *Eikenella corrodens*, *Odontomyces viscosus*, oral Spirochetes and *Candida albicans* have been detected on the tongue.<sup>10,17,18</sup>

The interaction between different oral microenvironments and tongue may be an important factor in the development of the whole oral bacterial niche. This interaction can be demonstrated by clear correlation between bacterial composition in these microenvironments and flora found in saliva.<sup>11</sup> The presence of *Streptococcus mutans* (*S. mutans*) in dental plaque is correlated with dental caries. The presence of *S. mutans* in saliva is considered to influence and contribute to the presence of these microorganisms on the tongue. When the number of colony forming units (CFU) in saliva increases, the number of CFU on tongue increases as well.<sup>10</sup>

### TONGUE COATING

The normal appearance of the dorsum of the tongue is either pinkish or with a coating, which is thin, white, moist and evenly distributed.<sup>10,11</sup> The formation of tongue coating is a normal phenomenon in periodontally healthy subjects as well as in patients suffering from gingivitis or periodontitis.<sup>5</sup>

Tongue coating tends to vary in color and thickness. The tongue coating is regarded as thin if the underlying tongue surface shows through faintly, whereas a thick coating is one that blots out the tongue surface completely. The presence of thin tongue coating was seen in 40% of patients and a thick coating was observed in 52% of patients, along with a small percentage of patients with unappreciable tongue coating.<sup>19-21</sup>

Tongue coating, which is adhered to the dorsum of the tongue, is comprised of bacteria, large amounts of desquamated epithelial cells released from the oral mucosa, leukocytes from periodontal pockets, blood metabolites and different nutrients.<sup>20-22</sup> Ultrastructural microscopic evidence indicates that the formation of tongue coating is closely related to the rate of multiplication of epithelial cells and the quantity of desmosomes and membrane-coating granules.<sup>10</sup> More than 100 bacteria may be attached to a single epithelial cell on the tongue dorsum, whereas only about 25 bacteria are attached to each cell in other areas of the oral cavity.<sup>23</sup>

Tongue coating is the major etiological factor for halitosis. Quirynen et al investigated 2000 patients visiting a multidisciplinary halitosis clinic and found that tongue

coating was the predominant cause of halitosis either alone (43.3%) or in combination with gingivitis and periodontitis (18.2%). A significant association between the organoleptic scores and the presence of tongue coating was also observed.<sup>24</sup>

### Factors Affecting Tongue Coating

The formation of tongue coating has been related to several factors including oral hygiene, age, dietary habits, periodontal status, smoking, salivary flow and use of denture.<sup>5</sup>

According to Ralph, elderly patients are more likely to exhibit a coated tongue because of a change in dietary habits toward the selection of softer diet, a reduced natural cleaning of the tongue, inability to physically cope with oral hygiene, a decrease in salivary flow and a change in the nature of the saliva.<sup>25</sup> In addition, a decrease in fungiform papillae and increase in filiform papillae with age has been reported.<sup>10</sup>

Soft foods or greasy foods rich in fat contribute significantly to accumulation of tongue debris.<sup>5,12</sup> Drinking coffee and smoking do not necessarily increase the amount of tongue coating but might give a false impression due to a discoloration of the coating. It has been hypothesized that drinking coffee falsely increases the amount of coating due to the dehydration effect of caffeine or to more discoloration.<sup>10,14</sup>

Van Turnout et al, in patients, recruited from a halitosis clinic conducted a study to analyze possible factors related to the presence of tongue coating. Medical history, dietary and oral hygiene habits were retrieved via a questionnaire. Data were recorded on organoleptic score and level of sulfur compounds in breath, anatomical features of the tongue dorsum, amount of tongue coating, tongue coating wet weight and salivary flow. The results showed that the level of oral hygiene was the strongest determinant factor for the presence of tongue coating. Smoking, presence of a denture, periodontal status and dietary habits also correlated although less obvious.<sup>5</sup>

According to Koshimune et al, the salivary flow rate is one of the key factors influencing the formation of tongue coating, with a low resting salivary flow (<0.1 ml/min) being related to the positive accumulation of coating.<sup>26</sup>

Numerous studies have shown that the extent of tongue coating tends to be greater in cases with periodontal involvement as compared to periodontally healthy subjects indicating that there is a correlation between the tongue coating wet weight and the presence of gingivitis/periodontitis.<sup>20-22</sup>

In patients with complaints of halitosis, the factors affecting tongue coating have to be taken into consideration in both the management of tongue coating as well as in its prevention of its occurrence or recurrence.<sup>5</sup>

### Measurements for Tongue Coating

Different methods of measurement have been proposed for tongue coating evaluation and quantification, taking into account various parameters, such as coating thickness, coating area and discoloration (Table 1). Tongue coating samples can be obtained by scraping the posterior portion of the tongue's dorsum using wooden spatula, plastic spoons, tooth brushes, swabs or gauze pads.<sup>19</sup>

### Relationship of Tongue Coating and Halitosis

The development of a predominant anaerobic microbiota associated with tongue coating has been considered an ideal microenvironment to produce malodorous compounds and, therefore, the relationship between tongue coating and halitosis has been assessed.<sup>1,14,32</sup>

Delanghe et al evaluated patients visiting a multidisciplinary halitosis clinic and found that of intraoral causes of halitosis, 51% were because of tongue coating, 17% — a result of gingivitis, 15% — a result of periodontitis and 17% — a result of combinations.<sup>33</sup>

Yaegaki and Sanada studied biochemical and clinical factors influencing oral malodor in periodontal patients and demonstrated that the concentration of disulfide increased in proportion to the total pocket depth, 60% of the VSC was produced from the tongue surface, and the amount of tongue coating was four times greater than in control subjects. It was suggested that not only microorganisms but also tongue coating is a factor enhancing the production of volatile sulfur compounds in patients with periodontal disease.<sup>21</sup>

Miyazaki et al, in a halitosis examination of 2,672 individuals aged 18 to 64 years, found that tongue coating was the main cause of halitosis in younger subjects and periodontal diseases together with tongue coating was mainly responsible for halitosis in older individuals.<sup>2</sup>

Morita and Wang investigated the relationship between sulcular sulfide level and halitosis in subjects with periodontal disease and found that the volume of tongue coating and the percentile of sites with bleeding upon probing were significantly associated with halitosis.<sup>34</sup>

Quiryrenen et al studied the effect of full-mouth disinfection on halitosis and microbial colonization of the tongue in patients with periodontal disease. It was observed that the baseline organoleptic ratings and the volatile sulfur compound (VSC) scores correlated well with the presence of tongue coating. No correlation was found between tongue coating and the total number of CFU on the dorsum of the tongue. Therefore, it was concluded that tongue coating *per se* and not the bacteria might be responsible for halitosis.<sup>10,22</sup>

Table 1: Measurements of tongue coating

Reference	Score	Description	
Gross et al <sup>27</sup> (1975)	0	No coating	
	1	Slight coating	
	2	Moderate coating	
	3	Heavy coating	
Kojima et al <sup>28</sup> (1985)	0	No coating (visual)	
	1	Thin coating of less than one-third of the back of the tongue	
	2	Thin coating of less than two third of the tongue or less than one-third covered with a thick coating	
	3	More than two-third covered with a thin tongue coating or less than two-third covered with a thick tongue coating	
Yaegaki and Sanada <sup>20</sup> (1992a)	4	More than two-third of the tongue is covered with a thick coating	
	Wet weight (mg)	Scraping off and weighing the tongue coating	
	Miyazaki et al <sup>2</sup> (1995)	0	None visible
		1	< 1/3 tongue dorsum surface covered
2		< 2/3 tongue dorsum surface covered	
	3	>2/3 tongue dorsum surface covered	
	Mantilla Gomez <sup>14</sup> (2001)	Discoloration	
		0	Pink
1		White	
2		Yellow/light brown	
3		Brown	
	4	Black	
	Thickness		
	0	No coating	
	1	Light-thin coating	
Oho et al <sup>29</sup> (2001)	2	Heavy-thin coating	
	Area	Area score × thickness score = tongue coating (range 0-6)	
	0	No tongue coating	
	1	<1/3 tongue dorsum surface covered	
	2	1/3-2/3 tongue dorsum surface covered	
	3	>2/3 tongue dorsum surface covered	
	Thickness		
	0	No coating	
	1	Thin tongue coating (papillae visible)	
	2	Thick tongue coating (papillae invisible)	
	Winkel et al <sup>30</sup> (2003)	Six areas grid	Tongue dorsum is divided into six areas (i.e. three posterior and three anterior)
Coating			
0		No coating	
1		Light coating	
2		Severe coating	
Discoloration			
0		No discoloration	
1		Light discoloration	
2		Severe discoloration	
		Score is calculated by adding all six scores (range 0-12)	
Kim et al <sup>31</sup> (2009)	Tongue coating area	Calculated from digital images obtained by the digital tongue imaging system (DTIS)	

## TONGUE HYGIENE METHODS

Successful treatment of halitosis depends on a correct diagnosis and the implementation of a cause-related therapy with focus on the reduction of the intraoral bacterial load

and/or the conversion of volatile sulfur compounds to nonvolatile substrates.<sup>23</sup>

Tongue hygiene has been considered to be a part of oral hygiene since ancient times. Africa, India, China, Arabia and



South America have a long history of the practice of tongue cleaning. Ancient tongue-scraping devices were constructed of thin, flexible strips of woods, various metals, ivory, whalebone, tortoise-shell and plastic. Many ancient religions have emphasized cleanliness of entire mouth, including the tongue. In India, daily ritual of oral hygiene included brushing of the teeth, scraping of the tongue and rinsing the mouth with concoctions of betel leaves, cardamom, camphor and other herbs.<sup>10,12</sup> According to Christensen, the practice of tongue cleaning in the western countries has been limited and little appreciated in the past centuries.<sup>12</sup>

The anatomic considerations have an important role to play as far as tongue hygiene and halitosis is concerned. The anterior portion of the tongue is usually less offensive than the smell found emanating from the posterior part. This is because the anterior portion is somewhat self-cleansing and more exposed to the outside environment, thus getting better oxygenation and therefore less likely to harbor odorigenic bacteria in large numbers. Many tongue functions require that the anterior portion of tongue touches firmly against hard palate. This friction produces a cleansing action therefore preventing any significant bacterial accumulation. The posterior portion of the tongue in comparison contacts the soft palate relatively gently and does not provide enough friction to produce any significant cleansing. Therefore, the posterior aspect of the tongue harbors a large number of anaerobic bacteria and is the most important area to clean. However, it should be borne in mind that it is always advisable to clean the entire dorsum of the tongue rather than limiting to anterior or posterior aspects.<sup>35</sup>

Tongue cleaning is a simple and fast procedure that helps to remove organisms and debris from the tongue. When tongue cleaning is practiced on a daily basis, the process becomes easier. Eventually, the person feels unclean when tongue debris has not been removed.<sup>12</sup>

Tongue hygiene involves cleaning the tongue on a regular basis using mechanical and/or chemical approaches for the prevention and treatment of halitosis.

### Mechanical Approach

The mechanical removal of tongue coating must be performed gently and thoroughly using implements which include tongue scrapers and toothbrushes.<sup>3</sup> Tongue scraper consists of a long strip of plastic or metal ribbon which is held in both hands and bent so that the edge can be pulled down over the dorsal surface of tongue removing the coating. The inverted bowl of spoon may also be used as an alternative for commercial tongue scraper.<sup>10</sup>

Faveri et al suggested that tongue scraping appears to be the most important hygiene procedure to reduce morning bad

breath in periodontally healthy subjects.<sup>36</sup> Tongue brushing is also an easy method of tongue cleaning provided that the gagging can be controlled. It has been suggested that the earlier the cleaning of tongue commenced in life, the easier it will be to control gagging reflex. According to Sarrazin, the best time for tongue cleaning is in the morning on an empty stomach so that vomiting ensued or gagging occurred.<sup>10</sup> The use of toothbrush for tongue cleaning is more popular because additional tool is not required. Quirynen et al observed reduced gagging with scraper in comparison with a brush.<sup>13</sup>

Most tongue cleaners are small, easy to clean and inexpensive and do not wear out rapidly. It has been demonstrated that toothbrushes are inferior to tongue scrapers in their ability to remove debris and microorganisms. According to Cochrane review, although the use of tongue scrapers was generally well accepted, the effects of tongue cleaning using scrapers or brushes appeared to be very short-lived and there was some limited evidence of tongue trauma which occurred with the use of tongue scraper.<sup>37</sup> Brushing the dorsum of tongue with toothpaste was more effective than brushing teeth. The duration of these effects varies from 15 to 100 minutes and depends on the device used to removing tongue coating, i.e. toothbrush or tongue scraper, lasting longer for tongue scraper than toothbrush.<sup>1</sup>

Christensen has suggested the following procedure for tongue-cleaning:<sup>12</sup>

- Place the tongue as far out of the mouth as possible.
- Observe the location of the debris accumulation. The debris is usually found on the most posterior aspect of the dorsum of the tongue.
- Place the tongue cleaner/scraper as far posterior as possible, and apply force on the scraper to flatten the tongue, making sure that it will make contact with the whole of the tongue. Many persons gag at this time, and practice is required to find the right positioning of the implement and to minimise the gag response.
- Pull the tongue cleaner forward slowly to the front of the mouth.
- Remove the debris from the cleaning device by placing it under a stream of running water.
- Repeat the scraping procedures several times until further debris cannot be removed.
- Clean and dry the cleaning device and store it until the next use.

The optimum number of times per day for tongue cleaning has not been clearly determined. Individuals with halitosis are well-advised to repeat the tongue-cleaning procedure several times during the day. Depending on the anatomy of the tongue and the foods eaten, some individuals do not accumulate debris on their tongues. These people may need little or no tongue cleaning, while others who have

large accumulations of debris need cleaning several times per day. It is important for the dentists to consider patients' oral characteristics and needs when advising them about the frequency of tongue cleaning.<sup>12</sup>

The average reduction in halitosis after tongue brushing ranged from 59 to 88%.<sup>9</sup> Tonzetich showed that brushing the tongue decreased volatile sulfur compounds by approximately 75% and reduced halitosis to an undetectable level in most cases. In contrast, toothbrushing resulted in less than 25% reduction of hydrogen sulfide and mercaptan.<sup>38</sup> A combination of tooth and tongue brushing or toothbrushing alone was found to have a beneficial effect on bad breath for up to 1 hour (73% and 30% reductions in volatile sulfur compounds respectively).<sup>1,24</sup>

The effect of tongue cleaning on taste sensation has been studied. Winkler et al suggested that tongue brushing is especially important for increasing taste acuity in geriatric patients who receive prostheses, because a dry mouth cannot distinguish the subtle flavors of good well-prepared food.<sup>39</sup> Hyde et al concluded that tongue cleaning improved taste sensation in geriatric individuals.<sup>40</sup>

Quirynen et al, in a cross-over, single-blind study on periodontitis-free, non-smoking, subjects with habitual oral hygiene evaluated the effect of tongue cleaning on the microbial load of tongue dorsum, extent of tongue coating and taste sensation for bitter, sweet, salt and sour for two weeks. They demonstrated significant reduction in tongue coating and limited reduction of the bacterial load when using a tongue cleanser, such as a brush or a scraper. They concluded that tongue cleaning improves taste sensation and seems to reduce the substrata for bacterial putrefaction, rather than the bacterial load.<sup>13</sup>

Tongue brushing in combination with other methods of oral hygiene has been shown to be effective in reducing the formation of dental plaque. Gross et al demonstrated reduction in plaque formation on teeth upon tongue-cleaning.<sup>27</sup> Contrastingly, Badersten et al found no difference in plaque accumulation between a 4-day period of tongue brushing and a 4-day period of no oral hygiene procedure.<sup>41</sup>

### Chemical Approach

The goal of chemical approach would be to reduce the proteolytic, anaerobic flora found on the tongue surface.<sup>1</sup> Different antimicrobial agents, such as chlorhexidine, cetylpyridinium chloride, triclosan, essential oils, chlorine dioxide, zinc salts, benzalkonium chloride, hydrogen peroxide and sodium bicarbonate, have been used in the treatment of halitosis, either alone or in combination, and either as a single mode of therapy or in combination with the mechanical approach of tongue hygiene.<sup>11</sup>

Results from a case series in halitosis patients showed a reduction of volatile sulfur compounds by 73.3% and halitosis by 68.6% suggesting a significant effect of chlorhexidine rinsing and tongue brushing after 1 week of treatment.<sup>18,32</sup> In other studies, chlorhexidine mouthrinses have been used in percentages of 0.2% as well as 0.12 in the treatment of halitosis, although, an adverse effect, such as staining of the dorsum of the tongue, has been observed.<sup>11</sup> Mouthrinses containing essential oils, such as Listerine, when evaluated for its efficacy to reduce tongue and crevicular odor-producing microorganisms in randomized double-blind protocols was found to be highly effective against halitosis, crevicular and tongue odoriferous microorganisms and the effect was statistically significant for at least 2 hours after treatment.<sup>42</sup>

### CONCLUSION

Halitosis is an unpleasant condition, which is universal and affects individuals of all ages. Research studies have implicated tongue as the primary source of volatile sulfur compounds, both in periodontally diseased and healthy individuals. Since the anatomic surfaces (dorsum, in particular) of the tongue serves as a potential reservoir for microorganisms, including periodontal pathogens, tongue hygiene may have an important role in the success of periodontal therapy. Also, in addition to the routine oral hygiene practice, tongue cleaning needs to be strongly recommended.

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