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Salivary parameters among Arabian snuff (Shammah) users

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ABSTRACT

الأهداف: تقييم معدل جريان اللعاب (SFR)، و pH، وسعة الدرء (BC) بين مستخدمي الشمه الأصحاء (SU) بالمقارنة مع غير المستخدمين الأصحاء (NSU).

الطريقة: أجريت دراسة الحالات والشواهد في كلية طب الأسنان، جامعة جازان، جازان، المملكة العربية السعودية خلال الفترة من مارس 2016م ومايو 2017م. اشتملت الدراسة على عينة من 27 SU و 30 NSU. تم جمع اللعاب غير المحسوب وتم تحديد SFR، و pH، و BC وتم تقييم صحة الأسنان باستخدام معدل الأسنان المسوسة، والمفقودة، والحشوه.

النتائج: كان مستخدمي الشمه أكبر سناً قليلاً من غير المستخدمين لها (6.9±28.9 مقابل 4.3±24.9 سنة). كما كان معدل تدفق اللعاب (0.46±0.68) و BC (2.07±5.7) أقل بكثير في مستخدمي SU مقارنة بغير المستخدمين NSU (0.37±7؛ p=0.002) مقابل DMFT (1.47±8.1؛ p<0.001). وعلى العكس من ذلك، كان DMFT في مستخدمي الشمه أعلى بكثير (5.17±7.96) مقارنة مع غير المستخدمين للشمه (3.46±4.53؛ p=0.007). وكان pH اللعابي و BC يرتبط بشكل كبير ومباشر (rs=0.576). كما كان السابق يرتبط ارتباطاً كبيراً ومباشراً مع SFR (rs=0.404)، ولكن هذا الأخير لم يكن. في المقابل، كان يرتبط BC عكسياً مع التسوس (rs=-0.385) و DMFT (rs=-0.399).

الخاتمة: يرتبط استخدام الشمه مع التغيرات في نوعية اللعاب (درجة الحموضة و BC). ويرتبط أيضاً مع سوء صحة الأسنان إما من خلال تأثيره المباشر أو الوساطة من خلال المعلمات اللعابية المتغيرة.

Objectives: To evaluate the salivary flow rate (SFR), pH, and buffer capacity (BC) among healthy shammah users (SU) in comparison with healthy non-shammah users (NSU).

Methods: This case-control study was conducted at the College of Dentistry, Jazan University, Jazan, Kingdom of Saudi Arabia between March 2016 and May 2017. A sample of 27 SU and 30 NSU were recruited. Unstimulated saliva was collected and SFR, pH, and BC

were determined. Dental health was assessed using the decay-missing-filled teeth (DMFT) index.

Results: Shammah users were slightly older than NSU (28.9±6.9 versus 24.9±4.3 years). Salivary flow rate was not significantly different, but pH (6.68±0.46) and BC (5.7±2.07) were significantly lower in SU users than in NSU (7±0.37; p=0.002 versus 8.1±1.47; p<0.001). Conversely, the DMFT in SU users was significantly higher (7.96±5.17) compared to that of NSU (4.53±3.46; p=0.007). Salivary pH and BC were significantly and directly correlated (rs= 0.576). The former was significantly and directly correlated with SFR (rs= 0.404), but the latter was not. In contrast, BC inversely correlated with decay (rs= -0.385) and DMFT (rs= -0.399).

Conclusions: Shammah use is associated with alterations in saliva quality (pH and BC). It is also associated with poor dental health either through a direct effect or mediation by altered salivary parameters.

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Smokeless tobacco (SLT) is a form of tobacco that is used by means other than smoking, including dipping and chewing tobacco, iqmik, snuff, snus, creamy snuff, naswar, tobacco gum, gutka, dissolvable tobacco, topical tobacco paste, toombak, and shammah.¹ The latter, also known as Arabian snuff, is highly prevalent in Yemen and southern Saudi Arabia.^{2,3} It is a dipping

form of SLT prepared by mixing powdered tobacco, calcium oxide, black pepper, oils, ash, and flavors.⁴ According to its color, there is black, white and grey colored shammah.² There is overwhelming evidence on the negative effects of SLT use on systemic health as a whole (which includes serious conditions such as esophageal and pancreatic cancers) and on the oral cavity including dental caries, gingivitis, and periodontitis not to mention oral cancer.⁵⁻¹⁰ So far, very few studies have assessed the effects of any of the SLTs, other than shammah, on the quality and quantity of a user's saliva.^{11,12}

Saliva, is an odorless and colorless hypotonic solution, of which 90% is secreted by salivary glands with an average rate of 0.4 ml/min unless otherwise stimulated.¹³ Salivary pH levels of healthy individuals range approximately 7.0 with variations up and down as a result of variations in the physiological state. On the other hand, no specific reference values for normal levels of salivary buffer capacity (BC) are available because of the use of different methods to determine BC, but they are generally affected by the physiological and health states.¹³ Saliva has multiple and essential functions that include, but not limited to, the following: 1) its thiocyanate and lysozymes ions are bactericidal, making it an important part of the nonspecific immune system of humans; 2) it helps to clean the mouth by washing away bacteria or food residues and freshening the breath; and 3) it is a lubricant that prevents friction and hence facilitates chewing, swallowing, and speaking.¹⁴ In fact, the optimal function of saliva is maintained as long as its pH, BC, and flow rate (SFR) are not altered.¹⁵ In other words, alterations in these parameters can jeopardize saliva's entire function and hence, endanger the integrity of the oral and systemic health.^{16,17} These parameters have been previously evaluated with respect to cigarette^{12,13,18,19} and waterpipe smoking²⁰ and some forms of SLT^{12,21} but not yet with respect to shammah use. Hence, the aim of this study was to evaluate the SFR, pH, and BC among healthy shammah users (SU) in comparison to healthy non-shammah users (NSU).

Methods. This study was a case control design classifying SU as cases and NSU as controls. It was

conducted at the College of Dentistry, Jazan University, Jazan, Saudi Arabia between March 2016 and May 2017. The study was approved by the Deanship of Scientific Research, Jazan University, as part of the project "Future Scientists IV". All participants signed informed consents only after they had been informed about the study objectives, its procedures, safety, and confidentiality of the collected data. The study was performed in accordance with the Declaration of Helsinki.

The sample size was calculated in order to detect a clinically significant difference in salivary pH between SU and NSU of no <0.3 pH units with a SD of 0.4. The power and significance level were set at 0.8 and 0.05, respectively. The resulting total sample size was 58 (29 per group). Participants were included if they fulfilled certain criteria: 1) were systemically healthy; 2) were 20 to 40 years old; 3) had ≥ 20 remaining teeth; and 4) used shammah daily for at least one year (for SU). On the other hand, individuals who were khat chewers, smokers, used any anti-inflammatory, antibiotic, or corticosteroid topically or systematically within the last 3 months, were using more than one type of shammah (white and black) concurrently, had acute or established gingivitis, moderate to severe periodontitis, oral mucosal lesions, and/or dental infections were excluded.

The demographic and clinical data were collected using a predesigned interview questionnaire. Dental health was assessed clinically using the decay-missing-filled teeth (DMFT) index. Resting SFR, pH, and buffer capacity were determined using an already validated chairside method, the Saliva-Check BUFFER kit (GC America, Inc.)²² following the manufacturer's instructions. Unstimulated saliva was collected between 9 a.m. and 12 noon at least 2 hours after meals and after following oral hygiene procedures as described elsewhere.^{23,24} Briefly, the participant was asked to sit and tilt his head anteriorly. As the saliva pooled in the floor of the mouth, he was asked to expectorate it into the provided measuring cup. After 5 minutes of doing this, unstimulated SFR was calculated by dividing the quantity of the collected saliva in ml by 5 and expressed as ml/min. The provided pH strip was immersed into the saliva sample for 10 sec, and the color change was used to estimate the resting pH according to the pH scale provided by the manufacturer. The supplied pipette was used to suspend 3 drops of the saliva on 3 predetermined areas of the provided buffering strip. Excess saliva was removed from the strip, and the color changes were read after 2 min against the provided buffer scale.

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Qualitative data were summarized and presented as frequencies and percentages, and the quantitative data were summarized and presented as means and standard deviations in addition to medians and interquartile ranges. Quantitative dependent variables (DMFT, SR, pH, and BC) were checked for normal distribution using the Kolmogorov-Smirnov test. Since the distribution was not normal, all between-group analyses were conducted using a non-parametric test (Mann Whitney U test). The potential correlations between the different variables were assessed using the Spearman rank-order correlation test in which values of 0 to 0.19 (very weak), 0.2 to 0.39 (weak), 0.4 to 0.59 (moderate), 0.6 to 0.79 (strong) and 0.8 to 1 (very strong). A *p*-value of <0.05 was considered significant. Data description and analyses were carried out using the Statistical Package for Social program Version 21 (Armonk, NY: IBM Corp.).

Results. The sample consisted of 57 Saudi male participants; 27 (47.4%) were SU. Thirteen of the SU (48.2%) reported using white shammah, and the rest reported using black shammah. The mean age of the participants was 28.9±6.9 years for SU and 24.9±4.3 years for NSU. With the exception of the filling component (F), DMFT, and its other components were significantly higher among SU than NSU (Table 1).

The salivary pH of the SU (6.68±0.46) was significantly lower than that of the NSU (7±0.37).

Similarly, salivary BC was significantly lower (5.7±2.07 versus 8.1±1.47). On the other hand, the SFRs of both groups were similar (Table 2).

Salivary parameters of SU according to shammah type are presented in Table 3. Salivary pH of white SU (6.49±0.37) was significantly lower compared to black SU (6.86±0.47). Although not significantly different, SFR and BC of white SU were lower than that of black SU.

Table 4 presents the values of the Spearman rank-order correlation between the different study variables. Salivary pH and BC were significantly and directly correlated (*r*s = 0.576). The former was significantly and directly correlated with SFR (*r*s = 0.404), but the latter was not. However, BC was the only salivary parameter that was correlated with DMFT and its D component; specifically, it inversely correlated with decay (*r*s: -0.385) and DMFT (*r*s: -0.399).

Discussion. Assessing salivary parameters is of paramount and more specifically with regard to practicing bad habits, healthy behaviors and so forth. Obviously, the bad habit of shammah use induces deteriorative qualitative salivary changes that endanger the oral hard and soft tissues. Shammah users in the current study had been doing so for a mean duration of 9.56±7.31 years (data not shown) indicating that the revealed salivary alterations might not be instantaneous or temporary. Instead, they appear to be permanent, and they might be among the mechanisms through which

Table 1 - Characterization and decay-missing-filled teeth (DMFT) of the study sample by shammah use.

Factors	Shammah users (n=27)		Non-shammah users (n=30)		P-value*
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)	
Age	28.93 (6.85)	28 (23-36)	24.9 (4.32)	24 (21.5-28.5)	0.028
Decay	6.07 (4.82)	6 (3-9)	3.47 (3.17)	3 (1-5)	0.032
Missing	0.96 (1.6)	0 (0-1)	0.23 (0.68)	0 (0-0)	0.001
Filling	0.96 (1.32)	1 (0-2)	0.87 (1.2)	0 (0-2)	0.868
DMFT	7.96 (5.17)	8 (1-2)	4.53 (3.46)	4 (2-7)	0.007

IQR - Inter-quartile range, *Mann Whitney U test.

Table 2 - Salivary flow rate (SFR), pH, and buffer capacity (BC) by shammah use.

Factors	Shammah users (n=27)		Non-shammah users (n=30)		P-value*
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)	
SFR	0.57 (0.31)	0.5 (0.4-0.7)	0.58 (0.24)	0.55 (0.4 - 0.725)	0.554
pH	6.68 (0.46)	6.4 (6.4-7)	7 (0.37)	7 (6.8 - 7.2)	0.002
BC	5.7 (2.07)	5 (4-8)	8.1 (1.47)	8 (7.75 - 9)	<0.001

IQR - inter-quartile range; *Mann Whitney U test.

Table 3 - Salivary parameters of shammah users by its type.

Factors	White (n=13)		Black (n=14)		P-value*
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)	
SFR	0.46 (0.16)	0.4 (0.4-0.6)	0.67 (0.39)	0.65 (0.375-0.74)	0.128
pH	6.49 (0.37)	6.4 (6.3-6.5)	6.86 (0.47)	6.7 (0.64-7.25)	0.025
BC	5.23 (1.79)	4 (4-7)	6.14 (2.28)	6.5 (4-8)	0.375

SFR - salivary flow rate, BC - buffer capacity, IQR - Inter-quartile range, *Mann Whitney U test

Table 4 - Correlations between different salivary parameters and dental health.

Variables	Group	Age	SFR	pH	BC	Decay	Missing	Filling	DMFT
Groups [‡]		-0.296*	0.08	0.403*	0.566*	-0.286*	-0.422*	-0.024	-0.357*
Age			-0.064	-0.153	-0.15	-0.252	-0.024	0.138	-0.217
SFR				0.404*	0.044	-0.075	0.114	0.096	-0.065
pH					0.576*	-0.203	-0.13	-0.068	-0.247
BC						-0.358*	-0.189	-0.125	-0.399*
Decay							0.407*	-0.013	0.901*
Missing								-0.005	0.57*
Filling									0.24
DMFT									

SFR - salivary flow rate, BC - buffer capacity, *significant spearman rank-order correlation, [‡]Shammah users (SU) were coded 1 and non-users (NSU) were coded 2. DMFT - decay-missing-filled teeth,

shammah exerts its deteriorative effects on health. It is known that healthy saliva protects the oral cavity and guarantees its healthy state. Conversely, deteriorated saliva loses its protective properties and exposes the oral structures to different insults. If such insults are chronic, they may lead to irreversible damage such as dental caries and much worse conditions. Hence, launching well-designed educational programs is a must in order to combat the habit of shammah use more seriously.

It is well known that shammah is a major risk/causative factor for many diseases,³ not to mention oral cancer.²⁵ However, its effects on the saliva parameters have not been assessed so far. The current study revealed significantly lower levels of pH and BC among adult healthy SU when compared with their NSU peers. We are going to contrast our results with that of smoking and other forms of SLT. Although one large study with 159 healthy volunteers did not reveal pH and BC differences according to smoking or alcohol status,¹⁹ Ahmadi-Motamayel et al¹³ reported results similar to our results (lower pH and BC) among cigarette smokers. In line with that, another study reported lower salivary pH among tobacco chewers in comparison to smokers; both groups, had significantly lower pH values when compared with that of healthy volunteers.¹² Moreover, salivary pH values have been found to be significantly

decreased with increased duration of use and time of exposure to SLT and with the presence of SLT-induced oral lesions whether precancerous or cancerous.²¹ Voelker et al¹⁸ and Khemiss et al²⁰ on the other hand, reported lower BC, but not pH values among cigarette and waterpipe smokers, respectively.

Although the literature consists of many contradictory findings about the effects of SLT and smoking on the saliva, there is substantial evidence about the negative and deteriorative effects of tobacco on salivary parameters and oral health. In the current study, BC, but not pH, was negatively associated with DMFT. Similar findings have been reported by others^{26,27} knowing that they did not assess salivary pH. Others have reported negative correlations of DMFT with pH^{28,29} knowing that they did not assess salivary BC. Worthy mentioning however, was the finding that BC and pH were directly correlated in our study ($r_s = 0.576$). This indicates that DMFT increased with a decrease in BC, which then caused a decrease in pH. Typically, dental caries is a multifactorial disease; these multiple factors contribute to decrease SFR, which causes a decrease in pH that in turn consumes the available buffering system resulting in a decrease of BC. Such a complex interrelationship between salivary

parameters and DMFT has been shown to some extent in our study, although the finding is difficult to interpret owing to the cross sectional design of our study. It does not appear to matter that the effects of shammah starts with inducing dental caries, which in turn causes deterioration of salivary parameters, or vice versa. In all cases, the overall result is the same: "shammah is deleterious". However, such a proposition is a hot topic and deserves further large-scale longitudinal studies.

With respect to shammah effects on DMFT, caries experience was reported more frequently among SU. The role of the reduced salivary pH and BC, which were diagnosed more frequently among SU, must be reemphasized as a possible mechanism or a potential result. However, no single study so far has linked using shammah with dental caries.⁴ Moreover, the potential association of other forms of SLT with dental caries is still an issue of controversy.³⁰⁻³⁴ Hence, further studies should be done in order to understand the real effects of shammah on dental structures.

Based on our results, shammah appears to induce qualitative salivary changes but not quantitative ones. Although salivary pH is a function of salivary FR, and salivary BC is a function of salivary pH, this was not the scenario in our study; reduced pH and BC were reported among SU unlike SFR which was comparable to that of NSU. Variable results regarding SFR have been reported among users of various tobacco types.^{20,35-38} On the other hand, and in contrast to our results, reduced SFR has been shown to be associated with dental caries in some studies.^{28,29,35}

Interestingly, a significant reduction in salivary pH was found among white SU compared to the users of black type. This might be attributed to the differences in their compositions, other than the tobacco, and their preparations. Apart from being wet-prepared by mixing tobacco with a solution of sodium carbonate, black shammah is mostly similar to the white, which is prepared as powder.^{2,5} This means that the aqueous nature of the black shammah might reduce the tobacco effects. Overall, it can be implied that white shammah is more dangerous than the black form.

Lack of matching both groups for DMFT and age was one important limitation in our study. This limitation might have biased the results and reduced their generalizability. In fact, we planned to include caries-free subjects, but this was difficult due to scarceness of such participants in our college. Including subjects with comparable DMFT was also impractical as it was time consuming. From a statistical point of

view, however, the highest between-group differences were for BC and pH followed by DMFT and age. Similarly, the values of Spearman's correlations also followed this pattern. In summary, this emphasizes the direct effects of shammah, not the age or DMFT or both, on the salivary parameters in addition to its effects on hard dental structures. Another major limitation in our study was the arbitrary evaluation of the gingival/periodontal health. Availability of exact measurements on gingival/periodontal health would have aided greatly in interpreting the results and accordingly in judging the exact effects of shammah on oral health. However, we emphasize here that the cases that had acute or established gingivitis or moderate to severe periodontitis were excluded. Excluding females was another major limitation. In fact, females, due to social standards, deny using shammah. Even when they admit using it, they refuse participating so long as the study entails collecting data on shammah use. Thus, it was very difficult to find female participants.

It must be emphasized here that with continuous use of shammah, the effects will be concentrated and become more dangerous leading ultimately to oral mucosal lesions that unfortunately include oral cancer.³⁹ Therefore, immediate national actions must be initiated to encourage shammah cessation.

Within the limitation of the current study, it can be concluded that the habit of shammah use is associated with alterations in the quality of saliva, specifically pH and BC. It is also associated with poor dental health either through direct effects or mediation by the altered salivary parameters as described above.

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