Comparative Evaluation of Altered Taste Perception among Oral Submucous Fibrosis Patients

**Abstract**

**Background:** Taste perception is an important factor in sustaining human life. Impairment of taste is one of the important features of oral submucous fibrosis (OSMF), and it has not received much attention, owing to limited research work in the field. Therefore, the present study was conducted to determine taste alteration in OSMF patients. **Materials and Methods:** A total of 200 participants, both males and females with the age range of 20 years to 55 years, were included in the study. Four basic tastants (i.e., sweet, salt, sour, and bitter) were prepared as follows: sucrose for sweet (0.1–1.0 mol/l), sodium chloride for salty (0.01–1.0 mol/l), citric acid for sour (0.320–0.032 mol/l), and quinine sulfate for bitter (0.01–1.0 mol/l) and full mouth rinse test was performed for a complete taste response examination, after which punch biopsy was taken from buccal mucosa to determine histopathological staging. The data obtained were tabulated and analyzed by the Pearson Chi-square test; $P < 0.05$ was considered statistically significant. **Results:** The overall results suggested that there was a significant alteration of taste. The sweet taste was altered followed by salty and bitter was least affected. **Conclusion:** The study points out at the significance of alteration in taste perception is OSMF patients related to sweet, salt, sour, and bitter taste by using physiological stimuli tastants.

**Keywords:** Oral submucous fibrosis, tastants, taste buds, taste perception

**Introduction**

Taste perception is an important factor in sustaining human life. Although commonly recognized as important for epicurean pleasure, taste is also indispensable for motivating food intake to obtain the energy and nutrients needed to maintain the body's functions. In addition, these senses provide warning messages and protection from food-borne and environmental toxins.[1]

Taste is perceived by taste buds which are present on papillae on dorsum of the tongue which are of four types: Filliform, Fungiform, Foliate, and Circumvallate. Taste buds mediate the taste sensation. They consist of taste cells and nerve fibers within specialized epithelial structures. The taste molecules are detected by chemosensitive receptors present in the taste buds. Taste buds have the capacity to regenerate and have a half-life of 10–15 days.[2]

The taste buds contain three types of taste receptors: Type I: Receptors detect the salt taste on the lateral border of the tongue, i.e., on fungiform papillae; Type II: Receptors can be found in the fungiform and circumvallate papillae and detect sweet, bitter, and umami tastes; and Type III: Receptors are found in the circumvallate and foliate papillae and can detect sour taste.[2–4]

Taste disorders are distressing for patients. They can also pose a serious threat to the health of older and more vulnerable patients, who can become malnourished through a loss of taste or changes in taste perception. Taste disorders are classified based on two principles: Type and site of the lesion. On the basis of the type of lesion, taste disorders are grouped as:

- **Quantitative disorder:** Hypergeusia (increased sensitivity to taste), hypogeusia (decreased sensitivity to taste), dysgeusia (taste confusion), and ageusia (complete loss of taste)[2]
- **Qualitative disorder:** Parageusia (abnormal taste sensation), pseudogeusia (taste sensation occurring inappropriate to the exciting stimuli), and...
Impairment of taste may be idiopathic or may result from head trauma; endocrine, metabolic, autoimmune and salivary gland disorders; medication use; cancer treatment (radiation or chemotherapy); viral, bacterial and fungal infections; certain potentially malignant conditions; or peripheral nerve damage due to invasive procedures including dental interventions. Impairment of taste is one of the important features of oral submucous fibrosis (OSMF).

OSMF is known to be prevalent in countries such as India, Pakistan, Taiwan, China, Malaysia, and Singapore. Overall, the prevalence of OSMF in India is about 0.5% with a range of 0.2%–1.2% in different regions of the country. It has been suggested that, chewing areca nut with and without tobacco may be involved in the pathogenesis of this condition. OSMF was described in 600 BC by Sushruta and was named “VIDARI.” In 1952, Schwartz coined the term “atrophia idiopathica mucosae oris.” Subsequently, in 1953, Joshi coined the term “Oral submucous fibrosis” for this condition.

Submucous fibrosis is an insidious, chronic disease affecting any part of the oral cavity and sometimes the pharynx. Occasionally, it is preceded by and/or associated with vesicle formation and is always associated with a juxta-epithelial inflammatory reaction followed by progressive hyalinization of the lamina propria. The later subepithelial and submucosal myofibrosis leads to stiffness of the oral mucosa and deeper tissues with progressive limitation in opening of the mouth and protrusion of the tongue, thus causing difficulty in eating, swallowing, and phonation.

There are various classifications of OSMF based on clinical and functional, histological, and clinicohistological features. JV Desa (1957) classified OSMF on the basis of clinical features such as stomatitis, vesiculitis, and fibrosis. Pindborg JJ (1989) used clinical features as well as their sequelae such as speech and hearing deficit may occur because of involvement of the tongue and the Eustachian tube.

The major disabilities like trismus and burning sensation that occur in the patient with OSMF are well-documented but impairment of the taste sensation has not received much attention. Therefore, the present study was conducted to evaluate the taste impairment of participants with OSMF.

Materials and Methods

A comparative study was conducted to assess and compare the taste perception among 200 outpatients between the age group of 20–55 years attending the Outpatient Department of Oral Medicine, Diagnosis and Radiology (OMDR) department.

Inclusion criteria

- Systemically healthy participants with clinically diagnosed OSMF
- Participants with the age group of 20–55 years
- Participants who have not undergone any treatment for OSMF earlier.

Exclusion criteria

- Participants with known systemic illness
- Participants taking medications which may cause alteration in perception of taste
- Lactating and pregnant females
- Participants allergic to taste solution
- Participants not willing to sign the consent.

Study design

A comparative study which included 200 patients, both male and females, aged 20–55 years was conducted in the department of OMDR to assess and compare the taste perception alteration among OSMF patients.

The ethical clearance was obtained from the Institutional Ethical Committee (GU/EC/ADC/1605). A written informed consent was obtained from the participants or their attendees before carrying out the examination which was in accordance with the World Medical Association’s Declaration of Helsinki.

Method of collection of data

One hundred participants with OSMF (test) and 100 healthy/without OSMF (control) were randomly selected from the routine OPD were divided into three groups;

- Group 1 (test): 100 participants having OSMF alone with habit of chewing/placing areca nut alone or with masala/with or without tobacco
- Group 2 (control 1): 50 participants without OSMF but having above-mentioned habits
- Group 3 (control 2): 50 participants without OSMF and without above-mentioned habits.

The OSMF participants were clinically examined and classified according to Khanna and Andrade classification.

Whole mouth rinse test was performed to determine taste in each subject. After completion of the taste response examination, punch biopsy was taken to determine the histopathological staging of OSMF in Group 1.

Preparation of tastants

Three different concentrations (low, medium, and high) of the four tastants were prepared for gustatory testing from the Department of Chemistry, Government College, Ajmer, Rajasthan, India.

- Sweet tastant: 34.2 gms, 188 gms, and 342 gms of sucrose were added to 1 L of water to prepare low (0.1 mol/l), medium (0.55 mol/l), and high (1.0 mol/l) concentrations, respectively
• Salty tastant: 0.58 gms, 29 gms, and 58 gms of sucrose were added to 1 L of water to prepare low (0.01 mol/l), medium (0.50 mol/l), and high (1.0 mol/l) concentrations, respectively
• Sour tastant: 6.14 gms, 33.7 gms, and 61.4 gms of sucrose were added to 1 L of water to prepare low (0.032 mol/l), medium (0.176 mol/l), and high (1.320 mol/l) concentrations, respectively
• Bitter tastant: 0.392 gms, 1.96 gms, and 3.92 gms of sucrose were added to 1 L of water to prepare low (0.001 mol/l), medium (0.005 mol/l), and high (0.01 mol/l) concentrations, respectively.

Before assessing the taste, the participants were asked not to eat/drink 1 h prior procedure and were also asked to rinse the mouth in distilled water.

**Taste determination**

Whole mouth rinse test was performed to determine taste in the participants. To start with, the lowest concentration of every tastant was randomly arranged. The participants were asked to sip and rinse for 10 s and then to spit out the tastant solution. They were then asked to identify the taste and the corresponding score was noted. If the subject was unable to identify the taste, another row with the next higher concentration of the tastant was given.

The procedure was carried out in the same way for every subject and all tastants and was followed by distilled water rinse which preceded each different tastant solution.

The scores were recorded based upon response to low concentration as 3, medium concentration as 2, and high concentration as 1 for all tastes, and the total score was made by adding the scores of different concentrations of all four tastants in each subject as low, medium, and high concentrations as 1–3, 4–6, and 7–9, respectively.

**Statistical evaluation**

The data collected were analyzed by applying descriptive and inferential statistical analysis using SPSS version 22.0 (IBM, Chicago, IL, USA). Pearson Chi-square test was used to compare the groups, and \( P \) values ≤0.05 were considered statistically significant.

**Results**

A comparative study was conducted to assess and compare the taste perception among 200 out patients between the age group of 20–55 years. The participants were divided into three groups. Group 1 which had patients with habit of chewing areca nut and also having OSMF which comprised of 100 participants. Group 2 patients who had habit of chewing or placing areca nut without OSMF which comprised of 50 participants and Group 3 patients were having no habit of chewing or placing areca nut and without OSMF which comprised of 50 subjects.

Out of total 200 participants, 13 (6.5%) were of the age group 11–20 years, 95 (47.5%) were of 21–30 years, 47 (23.5%) were of 31–40 years, 29 (14.5%) were of 41–50 years, and 16 (8%) were of 51–60 years.

Graph 1 demonstrates that in Group 1, 80% participants were males and 20% were females; similarly in Group 2, 86% were males and 14% were females, whereas in Group 3, 50% males and 50% females were seen.

Graphs 2-5 shows the comparison of response to sweet, salt, sour, and bitter tastes among Groups 1, 2, and 3, respectively. In response to sweet and salt taste among Groups 1, 2, and 3, all participants responded to low and medium concentrations; therefore, higher concentrations, i.e., C3 was not required to be tested. Similarly, in Group 1, response to sour taste was also seen in low and medium concentrations,
but in Groups 2 and 3, response to sour taste was noticed in low concentrations. In response to bitter taste among Groups 1, 2, and 3, all participants responded to low concentration; therefore, medium and high concentrations i.e., C2 and C3 were not required. The Pearson Chi-square test value was 55.767, 40.750, and 5.128 for taste response to sweet, salt, and sour among Groups 1, 2, and 3, respectively. The \( P \) value was statistically significant, i.e., \(<0.001\) for sweet and salt taste, whereas \( P \) value was nonsignificant, i.e., 0.77 (>0.05) for sour taste among Groups 1, 2, and 3, respectively. No statistics was computed for bitter taste because C1, C2, and C3 were constant in all the three groups.

In Table 1, comparison of response to sweet, salt, sour, and bitter taste among OSMF clinical Stages I, II, III, and IV is shown respectively. Among response to sweet taste, only 1 (100%) subject with clinical Stage I OSMF gave response to low concentration (C1); out of 41 subjects of clinical Stage II OSMF, 30 (73.17%) gave response to low concentration (C1) and 11 (26.83%) gave response to medium concentration (C2); and out of 34 subjects of clinical Stage III, 12 (35.29%) subjects gave response on low concentration (C1), 22 (64.71%) gave response to medium concentration whereas; out of 24 subjects of Stage IV, none responded on lower concentration (C1), all 24 (100%) subjects responded on medium concentration (C2). The \( P < 0.001 \) was highly significant.

Among response to salt taste, only 1 (100%) participant with clinical Stage I OSMF gave response to low concentration (C1); out of 41 subjects of clinical Stage II OSMF, 34 (82.9%) gave response on low concentration (C1), 7 (17.1%) gave response on medium concentration (C2); and out of 34 participants of clinical Stage III, 27 (79.4%) gave response low concentration (C1), 7 (20.6%) gave response to medium concentration (C2), whereas out of 24 participants of Stage IV, none responded to low concentration (C1), all 24 (100%) participants responded to medium concentration (C2). \( P < 0.001 \) which was highly significant.

Among response to sour taste, only 1 (100%) subject with clinical Stage I OSMF gave response to low concentration (C1); all 41 participants of Stage II OSMF gave response to low concentration (C1) and all 34 (100%) participants of clinical Stage III OSMF, all gave response on low concentration (C1) whereas out of 24 participants of Stage IV, 19 (79.16%) gave response to low concentration (C1) and 5 (20.84%) gave response to medium concentration (C2). The \( P < 0.001 \) which was significant.

Among response to bitter taste, out of 100 participants of Group 1, 1 (100%) participant of Stage I OSMF, 41 (100%) of Stage II OSMF, 34 (100%) of Stage III OSMF, and all 24 (100%) of clinical Stage IV OSMF gave response to low concentration (C1). No statistics is computed as C1, C2, C3 was constant.

Table 2 demonstrates the correlation between complaints and clinical staging in Group 1 subjects. Out of 100 participants in Group 1, 48 (48%) had burning sensation, 50 (50%) had reduced mouth opening, and 2 (2%) had ulceration. Out of 100 participants of Group 1, 1 (1%) subject had clinical Stage I OSMF, 41 (41%) participants had Stage II, 34 (34%) were of Stage III, and 24 (24%) participants had Stage IV OSMF. In Stage I OSMF, there was 1 (100%) subject with ulceration and none of burning sensation and reduced mouth opening. Out of 41 patients of Stage II, 24 (58.5%) participants were having burning sensation, 16 (39.2%) participants were having reduced mouth opening, and 1 (2.3%) was having ulceration. Out of 34 participants of clinical Stage III, 12 (35.3%) had burning sensation, 22 (64.7%) had reduced mouth opening, and none was having ulceration. Out of 24 patients of Stage IV OSMF, 12 (50%) had burning sensation, 12 (50%) had reduced mouth opening and none was having ulceration. \( P < 0.001 \) was statistically significant.

Table 3 demonstrates the comparison between histological staging and clinical staging in Group 1 participant. Out of 100 participants of Group 1, 15 (15%) participants had histological Stage I OSMF, 40 (40%) had Stage II, 30 (30%) were of histological Stage III, and 15 (15%) had histological Stage IV OSMF. The only 1 (1%) subject having clinical Stage I OSMF had also
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Histological Stage I OSMF. Out of 41 (41%) participants of clinical Stage I, 14 (34.2%) had histological Stage I OSMF, 26 (63.3%) had histological Staging II, 1 (2.5%) had histological Staging III, and none had histological Stage IV OSMF. Out of 34 (34%) participants of clinical Stage II, 14 (41.1%) had histological Stage II OSMF, 20 (58.9%) had histological Stage III, and none had histological Stage I and IV OSMF. Out of 24 (24%) of clinical Stage IV OSMF, 9 (37.5%) had histological Stage III OSMF, 15 (62.5%) had histological Stage IV, and none with histological Stage I and II OSMF. Spearman correlation was 841 which suggests positive correlation.

Table 1: Comparison of response to sweet, salt, sour, and bitter taste among oral submucous fibrosis clinical staging, i.e., I, II, III, and IV participants

| Tastants | Concentrations | Clinical staging (%) | Df | Pearson $\chi^2$ | $P$ |
|----------|----------------|----------------------|----|-----------------|-----|
|          |                | I                  | II | III | IV |                   |
| Sweet   | C1             | 100                | 73.17 | 35.29 | - | 45.804 | 45.804 | <0.001 |
|         | C2             | -                  | 26.83 | 64.71 | 100 |                   |
|         | C3             | -                  | -    | -   | -   |                   |
| Salt    | C1             | 100                | 82.9 | 79.4 | - | 3 | 37.413 | <0.001 |
|         | C2             | -                  | 17.1 | 20.6 | 100 |                   |
|         | C3             | -                  | -    | -   | -   |                   |
| Sour    | C1             | 100                | 100  | 76.16 | - | 3 | 16.667 | 0.001 |
|         | C2             | -                  | -    | -   | 23.84 | |
|         | C3             | -                  | -    | -   | -   | |
| Bitter  | C1             | 100                | 100  | 100  | 100 | - | |
|         | C2             | -                  | -    | -   | -   | |
|         | C3             | -                  | -    | -   | -   | |

Discussion

Taste is the sense by which the chemical qualities of food in the mouth are distinguished by the brain, based on information provided by the taste buds. Human beings are able to perceive the four basic tastes: Sweet, salt, sour, and bitter. Recently, a new taste umami had also been incorporated.[9]

Chronic chewing of areca nut also causes continuous irritation to the oral cavity and other intraoral structures causing conditions like OSMF which may affect gustation with other clinical features as there is depappilation of the tongue which is in accordance with Zhang et al.[10] and also according Wang et al.[11] the presence of inflammatory mediators present in OSMF also alter taste perception. In the Indian population, areca nut chewing has been reported to be presently fourth dependent substance preceded by nicotine, alcohol, and caffeine.[12] Moreover, Deeplaxmi et al.,[6] Uwe Wollina et al.,[13] and Sabharwal et al.[14] have suggested that OSMF has a high prevalence in entire South East Asia including India.

In the present study, the participants with habit of areca nut and having OSMF, i.e., Group 1 suggested a strong male predilection which is in accordance with Jain et al.[15] which showed results that male:female ratio 2.67:1 and Sharma et al.[16] which showed 81.38% males and 18.62% females with OSMF.

Out of 100 participants with OSMF and areca nut habit, most of them had burning sensation and reduced mouth opening. Features such as ulceration was found only in participants with clinical Stage I, II which is in accordance with Rajendran,[17] Gupta et al.[18] which states that most common features of OSMF include burning sensation and reduced mouth opening and features such as ulceration are found in early stages of OSMF.[17,18]
In the present study, there was linear relationship between clinical and histological staging which is suggestive that clinical features are reflection of underlying histological changes and also suggests the accuracy of classification system being used, i.e., Khanna and Andrade.[8,14,19]

In the present study, the participants were divided into three different groups to determine that weather it is the content of areca nut or the disease which is responsible for change in taste perception which is in accordance with Khader et al.[9] Participants with any coexisting systemic illness or with any other local disease such as tobacco-related lesions were excluded because they also affect taste perception which is in accordance with Deeplaxmi et al.[6] and Khader et al.[9] In the present study, three different concentrations (low, medium, and high) for four basic tastants (sweet, salt, sour, and bitter) were prepared for assessing the altered taste perception. The tastants used for sweet, salt sour, and bitter are sucrose, sodium chloride, citric acid, quinine sulphate, respectively, which is in accordance with Nakagawa et al.[20] and Rousmans et al.[21]

There are various methods of gustatory testing such as full mouth rinse test, edible taste strip, electrogustometry, filter paper disk method, olfactory testing,[20] but full mouth rinse test was performed for each t astant with different concentrations in this study so that all areas of the mouth can be covered for assessment of a taste perception as taste receptors are present at sites other than tongue also which might go undetected in other methods so scoring for each t astant was performed according to response to different concentrations which is in accordance with Deeplaxmi et al.[6]

In the present study, it was found that majority of the patients responded to medium concentration (C2) of sweet tastant, many subjects responded to medium concentration (C2) of salt tastant but less as compared to sweet. In case of sour, medium concentration was required for very few and for bitter tastant all responded to lower concentration (C1) only which suggested that sweet is the taste to get alter most followed by salt and bitter is least affected alteration depends on the atrophy of specific papilla due to areca nut chewing and sweet taste sensitivity is more affected due to depapillation in anterior region of tongue which consist of fungiform papillae which is in accordance with Zhang et al.[10] whereas foliate papillae and circumvallate papillae are affected less which are responsible for sour and bitter taste perception respectively due to areca nut chewing which is in accordance Deeplaxmi et al.[6] which suggested that sweet is the taste to alter most followed by salt and bitter and sour were least affected. As in case of OSMF there is inflammation of entire oral cavity so the level of inflammatory mediators is also high and these also regulates the response of bitter taste (tumor necrosis factor-α, insulin-like growth factor-1, and Leptin levels) along with taste buds thus causing high sensitivity for bitter taste which is in accordance with Wang et al.[11] hence bitter taste is not affected even with severity of disease whereas taste like sweet and salt get affected by both the depapillation which is major in anterior region of tongue as well as with the overall effect of OSMF.

Conclusion
The present study demonstrated altered taste perception in OSMF patients, related to sweet, salt, sour and bitter taste, by using physiological stimuli tastants. Significant taste alteration was found with sweet followed by salt and bitter was least affected. Thus it is reasonable to assume that OSMF will produce taste impairment. Aside from increasing risk of cancer the changes in taste perception in OSMF patients often leads to depression, anorexia and weight loss so proper balanced diet should be given as a part of the overall treatment of OSMF with other modes of treatment. However further bigger sample size and long-term studies are required for more conclusive results.

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Conflicts of interest
There are no conflicts of interest.

References
1. Hong JH, Omur‑Ozbek P, Stanek BT, Dietrich AM, Duncan SE, Lee YW, et al. Taste and odor abnormalities in cancer patients. J Support Oncol 2009;7:58‑65.

2. Ambaldhage VK, Puttabuddi JH, Nunsavath PN, Tummuru YR. Taste disorders: A review. J Indian Acad Oral Med Radiol 2014;26:69‑76.

3. Su N, Ching V, Grushka M. Taste disorders: A review. J Can Dent Assoc 2013;79:d86.

4. Kumar GS. Orbans Histology and Embryology. 12th ed. India:Elsevier; 2011. p. 241.

5. Klasser GD, Utsman R, Epstein JB. Taste change associated with a dental procedure: Case report and review of the literature. J Can Dent Assoc 2008;74:455‑61.

6. Deeplaxmi R, Sakarde SB, Sur J, Singh AP, Jain S, Mujoo S. Altered taste perception in oral submucous fibrosis: A research. J Indian Acad Oral Med Radiol 2012;24:288‑91.

7. De Roy PG. Helsinki and the Declaration of Helsinki. World Med J 2004;50:1:9.

8. Khanna JN, Andrade NN. Oral submucous fibrosis: A new concept in surgical management. Report of 100 cases. Int J Oral Maxillofac Surg 1995;24:433‑9.

9. Abdul Khader NF. Gustatory changes due to areca nut chewing and OSMF. Int J Oral Med 2014;26:69‑76.

10. Klasser GD, Utsman R, Epstein JB. Taste change associated with a dental procedure: Case report and review of the literature. J Can Dent Assoc 2008;74:455‑61.

11. Abdul Khader NF. Gustatory changes due to areca nut chewing and OSMF. Int J Pharm Bio Sci 2015;6:735‑43.

12. Zhang GH, Zhang HY, Wang XF, Zhan YH, Deng SP, Qin YM. The relationship between fungiform papillae density and detection threshold for sucrose in the young males. Chem Senses 2009;34:93‑9.

13. Swarup N, Naya MT, Chowdhary Z, Naya A, Naina, Does MC. Oral Submucous Fibrosis Affect the Hearing Ability of an
Individual? A Cross-Sectional Study in North Indian Population. Pesqui Bras Odontopediatria Clin Integr 2019; 19:4745.

13. Wollina U, Verma SB, Ali FM, Patil K. Oral submucous fibrosis: An update. Clin Cosmet Investig Dermatol 2015;8:193-204.

14. Sabharwal R, Gupta S, Kapoor K, Puri A, Rajpal K. Oral submucous fibrosis – A review. J Adv Med Dent Sci Res 2013;1:29-37.

15. Jain AK, Nigam R, Gupta R. Oral sub mucous fibrosis – A clinicopathological study. J Evol Med Dent Sci 2013;2: 2984-8.

16. Sharma R, Sunder Raj S, Miahra G, Giridhar Reddy Y, Shenava S, Narang P. Prevalence of oral submucous fibrosis in patients visiting dental college in rural area of Jaipur, Rajasthan. J Indian Acad Oral Med Radiol 2012;24:1-4.

17. Rajendran R. Oral submucous fibrosis: Etiology, pathogenesis, and future research. Bull World Health Organ 1994;72:985-96.

18. Gupta M, Mishra P, Shrivastava K, Singh N, Singh P. Oral submucous fibrosis-current concepts of aetiology and its management. J Appl Dent Med Sci 2015;1:28-39.

19. Priyadharshini B. Classification system for oral submucous grading – A review. Int J Sci Res 2014;3:740-44.

20. Nakagawa M, Mizuma K, Inui T. Changes in taste perception following mental or physical stress. Chem Senses 1996;21:195-200.

21. Rousmans S, Robin O, Dittmar A, Vernet Maury E. Autonomic nervous response associated with primary tastes. Chem Senses 2000;25:709-18.