# IMMEDIATE SALIVARY FLOW RESPONSE TO HONEY-BASED GUSTATORY STIMULATION IN REMOVABLE DENTURE WEARERS WITH AND WITHOUT XEROSTOMIA: A PILOT CASE-SERIES

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## Abstract

**Background:** Xerostomia and reduced salivary flow may impair denture retention, mucosal tolerance, and oral comfort in removable denture wearers. **Aim:** This pilot study evaluated the immediate salivary response to honey-based gustatory stimulation in denture wearers with and without xerostomia. **Methods:** Six removable denture wearers were included: three without xerostomia and three with xerostomia-associated hyposalivation. Whole saliva was collected by passive drooling at baseline, after water rinse, and after rinsing with a 20% honey solution. **Results:** Baseline salivary flow was 0.35 ± 0.05 mL/min in patients without xerostomia and 0.07 ± 0.02 mL/min in xerostomic patients. After water rinse, values increased slightly to 0.38 ± 0.04 and 0.09 ± 0.02 mL/min, respectively. Honey-based stimulation increased salivary flow to 0.63 ± 0.06 mL/min in the non-xerostomia group and 0.25 ± 0.06 mL/min in the xerostomia group, corresponding to relative increases of 81.5% and 239.4%. No immediate adverse reactions were reported. **Conclusions:** Honey-based gustatory stimulation produced an immediate measurable increase in salivary flow in removable denture wearers, including patients with xerostomia-associated hyposalivation. These preliminary findings support further controlled studies on its clinical relevance and safety.

**Keywords:** removable dentures; xerostomia; hyposalivation; salivary flow; honey-based stimulation.

## 1. Introduction

Saliva plays a central role in the functional success of removable prosthetic rehabilitation, particularly in patients wearing complete or partial dentures, and beyond its lubricating effect, saliva contributes to denture retention through adhesion, cohesion, surface tension, and the formation of a thin interfacial film between the prosthetic base and the oral mucosa. Alterations in salivary quantity or quality may therefore compromise prosthetic stability, increase frictional trauma, reduce mucosal tolerance, and negatively affect patient comfort. Recent investigations in removable denture wearers have shown that salivary conditions can be modified by topical or prosthesis-associated interventions, supporting the clinical relevance of monitoring salivary parameters in this population [1].

Xerostomia and hyposalivation represent distinct but closely related clinical entities. Xerostomia refers to the subjective sensation of oral dryness, whereas hyposalivation denotes an objectively reduced salivary flow rate. In removable denture wearers, both conditions may interfere with adaptation to prosthetic appliances, denture retention, mastication, speech, and global patient satisfaction. Contemporary evidence indicates that salivary dysfunction is directly involved in prosthetic challenges, particularly in patients who depend on a stable mucosal–prosthetic interface for functional rehabilitation [2]. Moreover, reduced salivary flow and xerostomia have been


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associated with impaired adaptation to conventional complete dentures and lower satisfaction with removable denture performance [3,4].

The clinical implications of salivary dysfunction extend beyond mechanical prosthetic instability. Removable dentures create a complex ecological niche in which reduced salivary clearance, denture biofilm, mucosal trauma, and nocturnal denture wearing may favor microbial colonization. Candida colonization has been reported in patients using different prosthetic appliances, and xerostomia appears to be particularly relevant in vulnerable groups such as complete denture wearers and patients with systemic conditions including diabetes mellitus [5,6]. In this context, dry mouth has been described as a frequent and clinically relevant problem among complete denture wearers, with potential consequences for mucosal inflammation, burning sensation, denture stomatitis, and reduced oral health-related quality of life [7].

Several therapeutic approaches have been proposed for the management of xerostomia, including salivary substitutes, oral gels, topical agents, pharmacological sialogogues, and gustatory stimulation. Recently, honey-based oral rinses have attracted attention as simple, natural, and well-tolerated interventions for xerostomia. Randomized clinical studies have reported beneficial effects of Manuka honey and thyme honey mouth rinses in elderly, medically compromised, and polypharmacy-associated xerostomic patients, including improvements in subjective dryness and salivary-related parameters [8-10]. Broader reviews of xerostomia management further support the need for accessible topical strategies capable of improving oral lubrication and patient comfort [11].

Despite these advances, evidence remains limited regarding honey-based gustatory stimulation specifically in removable denture wearers with xerostomia. This gap is clinically relevant because salivary dysfunction, prosthetic material behavior, mucosal tolerance, and microbial biofilm formation are closely interconnected. Antihypertensive medication, changes in salivary pH, and PMMA-based prosthetic materials may further influence the oral environment of denture wearers [12,13]. In addition, denture stomatitis and Candida-associated inflammation remain multifactorial conditions in which salivary protection, host immunity, prosthetic hygiene, and microbial virulence interact [14-18].

Therefore, the present pilot study aimed to evaluate the immediate salivary flow response to honey-based gustatory stimulation in removable denture wearers with and without xerostomia. By comparing baseline salivary flow, water rinse response, and honey-induced salivary stimulation, this exploratory study sought to assess the feasibility, tolerability, and preliminary clinical relevance of a simple honey-based protocol in a prosthetic patient population.

## 2. Materials and Methods

### *2.1. Study design and participants*

This study was designed as a pilot interventional case series with intra-subject comparison, and the objective was to evaluate the immediate salivary flow response to honey-based gustatory stimulation in removable denture wearers with and without xerostomia. Each participant served as his or her own control, with salivary flow measured at baseline, after water rinse, and after honey-based stimulation.

The pilot sample included six removable denture wearers. Three patients had no or minimal xerostomia and physiological unstimulated salivary flow, while three patients had subjective xerostomia and reduced unstimulated salivary flow compatible with hyposalivation, and all patients had been wearing a removable complete or partial


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denture for at least 6 months and were able to understand and follow the study protocol.

Patients were excluded if they had a known allergy or hypersensitivity to honey or bee-derived products, uncontrolled diabetes mellitus, active oral infection requiring immediate treatment, acute ulcerative oral lesions, previous or ongoing radiotherapy in the head and neck region, diagnosed Sjögren syndrome, current use of systemic sialogogues, antibiotic or antifungal therapy within the previous 4 weeks, or inability to comply with saliva collection procedures. Patients were also excluded if they had eaten, consumed beverages other than water, smoked, chewed gum, performed oral hygiene procedures, or used mouth rinses within 90 minutes before saliva collection.

### *2.2. Clinical assessment and group allocation*

Before saliva collection, each participant underwent a standardized clinical evaluation performed by the same operator, and the following variables were recorded: age, sex, type of removable prosthesis, duration of denture use, denture wearing habits, nocturnal denture wearing, subjective oral dryness, and systemic medication with potential xerogenic effects.

The oral mucosa was examined for erythema, denture-related mucosal irritation, traumatic lesions, burning sensation, and clinical signs suggestive of denture stomatitis. The prosthesis was visually assessed for hygiene status and obvious mechanical instability.

Subjective xerostomia was assessed using a 10-point visual analogue scale, where 0 indicated absence of oral dryness and 10 indicated maximum perceived oral dryness. Patients with low VAS scores and physiological unstimulated salivary flow were assigned to the non-xerostomia group, whereas patients with high VAS scores and reduced unstimulated salivary flow were assigned to the xerostomia group.

### *2.3. Salivary flow measurement protocol*

Whole saliva was collected using the passive drooling method. All measurements were performed under standardized conditions, in the same clinical environment, with participants seated upright and with the head slightly tilted forward. Patients were instructed to avoid speaking, unnecessary swallowing, or excessive tongue movements during collection.

Before the first measurement, patients rested for 5 minutes. Unstimulated whole saliva was then collected for 5 minutes into a sterile graduated container. The collected volume was recorded in milliliters, and the salivary flow rate was calculated according to the following formula:

Salivary flow rate = collected saliva volume/collection time

The final value was expressed in mL/min. A baseline unstimulated salivary flow rate around 0.3–0.4 mL/min was considered compatible with physiological salivary secretion, whereas values ≤0.1 mL/min were considered compatible with hyposalivation.

After baseline saliva collection, participants rested for 5 minutes, and they then rinsed the oral cavity with 10 mL of plain water for 60 seconds and expectorated completely. After a 1-minute waiting period, saliva was collected again for 5 minutes using the same passive drooling method. This step was used as an intra-subject control condition.

### *2.4. Honey-based gustatory stimulation procedure*

After the water rinse measurement, participants rested for another 5 minutes. Honey-based stimulation was performed using a freshly prepared 20% honey solution, consisting of 2 mL of natural honey diluted in 8 mL of water, for a total volume of 10 mL.

Participants rinsed the oral cavity with the honey-based solution for 60 seconds and then expectorated completely. After a 1-minute waiting period, whole


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saliva was collected for 5 minutes using the same passive drooling method.

At the end of the procedure, participants rinsed thoroughly with plain water to reduce residual sugar exposure on the oral mucosa, remaining teeth, and denture surfaces. Denture hygiene instructions were reinforced after completion of the protocol.

### *2.5. Outcomes, safety assessment and statistical analysis*

The primary outcome was the immediate change in whole salivary flow rate after honey-based gustatory stimulation compared with baseline. Secondary outcomes included the change in salivary flow after water rinsing, comparison of salivary response between patients with and without xerostomia, relative percentage increase in salivary flow after honey-based stimulation, subjective tolerability of the protocol, and transient subjective improvement in oral moisture.

Relative percentage increase was calculated using the following formula:

Relative increase (%) = [(post-stimulation flow − baseline flow) / baseline flow] × 100

All participants were monitored during and immediately after the honey-based stimulation protocol. Burning sensation, nausea, mucosal irritation, local discomfort, unpleasant taste, or any other immediate adverse reaction was recorded.

Because this was a pilot case-series with a very small sample size, the analysis was primarily descriptive, and continuous variables were expressed as mean ± standard deviation and range, where appropriate. Individual patient values were also reported to preserve clinical transparency. Salivary flow values were summarized for each group at three time points: baseline, after water rinse, and after honey-based stimulation.

Absolute and relative changes from baseline were calculated for each participant and compared descriptively between groups, no inferential statistical testing was performed, given the exploratory design and the limited number of participants.

## 3. Results

### *3.1. Patient characteristics and baseline salivary status*

Our pilot study included six removable denture wearers, divided into two clinically defined groups: three patients without xerostomia and three patients with subjective xerostomia and objective hyposalivation, and patients without xerostomia had low VAS xerostomia scores, between 0 and 2, while patients with xerostomia reported higher scores, between 7 and 9.

At baseline, unstimulated salivary flow was clearly different between groups. The non-xerostomia group showed a mean unstimulated salivary flow rate of 0.35 ± 0.05 mL/min, consistent with physiological salivary secretion, and in contrast, the xerostomia group presented a mean unstimulated salivary flow rate of 0.07 ± 0.02 mL/min, compatible with objective hyposalivation. As shown in Figure 1, baseline unstimulated salivary flow was markedly lower in patients with xerostomia than in those without xerostomia.

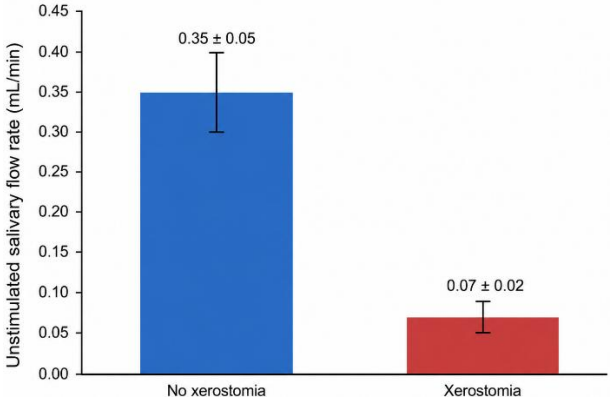


**Figure 1.** Baseline unstimulated salivary flow rate in removable denture wearers with and without xerostomia. Data are presented as mean ± SD.


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### *3.2. Salivary flow response after water rinse and honey-based stimulation*

Water rinsing produced only a modest increase in salivary flow in both groups. In patients without xerostomia, mean salivary flow increased from 0.35 ± 0.05 mL/min at baseline to 0.38 ± 0.04 mL/min after water rinsing. In patients with xerostomia, the corresponding increase was from 0.07 ± 0.02 mL/min to 0.09 ± 0.02 mL/min.

Honey-based gustatory stimulation produced a more pronounced salivary response. In the non-xerostomia group, mean salivary flow increased to 0.63 ± 0.06 mL/min, corresponding to an average relative increase of 81.5% compared with baseline. In the xerostomia group, mean salivary flow increased to 0.25 ± 0.06 mL/min, corresponding to an average relative increase of 239.4%.

As shown in Figure 2, honey-based stimulation induced a greater salivary response than water rinsing in both groups, and although the relative increase was higher in patients with xerostomia, their final stimulated salivary flow values remained lower than those observed in patients with normal baseline salivation.

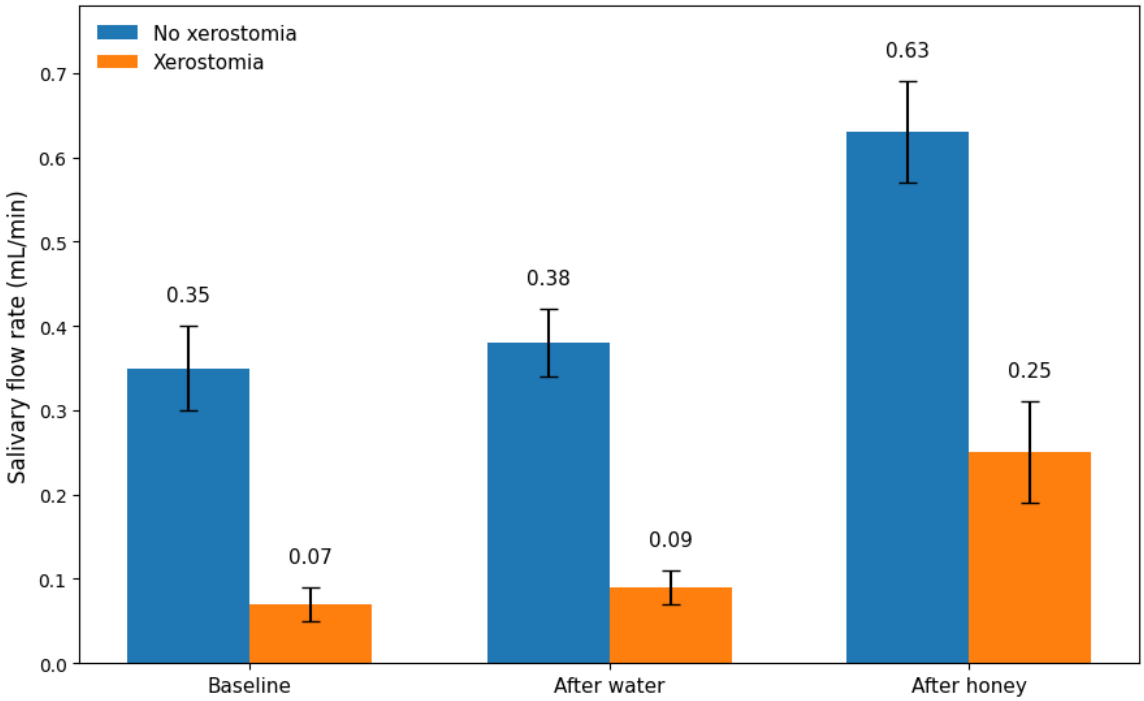


**Figure 2.** Salivary flow response at baseline, after water rinse, and after honey-based gustatory stimulation in removable denture wearers with and without xerostomia. Data are presented as mean ± SD.

### 3.3. Individual salivary flow measurements

Individual salivary flow measurements are presented in Table 1. Patients without xerostomia showed baseline unstimulated salivary flow values ranging from 0.31 to 0.40 mL/min, whereas patients with xerostomia presented markedly lower baseline values, ranging from 0.05 to 0.09 mL/min.

After water rinsing, only minor increases were observed in all patients. In contrast, honey-based gustatory stimulation produced a measurable increase in salivary flow in each case. Among patients with xerostomia, the highest post-stimulation values were recorded in P4 and P6, while P5, who had the lowest baseline salivary flow, showed a smaller absolute response.


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**Table 1.** Individual xerostomia scores and salivary flow measurements

| *Patient* | Clinical group | Xerostomia VAS | Baseline flow (mL/min) | After water (mL/min) | After honey stimulation (mL/min) |
|---|---|---|---|---|---|
| *P1* | No xerostomia | 1 | 0.34 | 0.38 | 0.62 |
| *P2* | No xerostomia | 2 | 0.31 | 0.35 | 0.58 |
| *P3* | No xerostomia | 0 | 0.40 | 0.42 | 0.70 |
| *P4* | Xerostomia | 8 | 0.08 | 0.10 | 0.26 |
| *P5* | Xerostomia | 9 | 0.05 | 0.07 | 0.18 |
| *P6* | Xerostomia | 7 | 0.09 | 0.11 | 0.30 |

### 3.4. Tolerability and clinical interpretation

All participants tolerated the honey-based stimulation protocol well, and no immediate adverse reactions, including a burning sensation, nausea, mucosal irritation, or local discomfort, were reported during or immediately after the procedure. Patients with xerostomia described a transient subjective improvement in oral moisture following honey-based stimulation.

Within the xerostomia group, the most pronounced absolute salivary responses were observed in patients P4 and P6, and by contrast, patient P5, who presented the lowest baseline salivary flow rate, showed a measurable but smaller absolute increase after stimulation. This observation suggests that the magnitude of the salivary response may depend, at least in part, on the residual functional capacity of the salivary glands.

Overall, these preliminary findings indicate that honey-based gustatory stimulation may induce an immediate increase in whole salivary flow in removable denture wearers, including patients with xerostomia-associated hyposalivation. However, given the exploratory nature of the study and the limited sample size, these results should be interpreted as hypothesis-generating and require validation in larger controlled cohorts.

## 4. Discussion

The present pilot study evaluated the immediate salivary flow response to honey-based gustatory stimulation in removable denture wearers with and without xerostomia. The main observation was that honey-based stimulation produced a measurable increase in whole salivary flow in both groups, with a proportionally greater response among patients with xerostomia-associated hyposalivation. However, despite this relative increase, the final stimulated flow values in xerostomic patients remained lower than those recorded in participants with normal baseline salivation. These findings suggest that honey-based gustatory stimulation may enhance residual salivary secretion, but it does not fully compensate for reduced glandular output in patients with marked hyposalivation.

Salivary function is particularly important in removable prosthetic rehabilitation because denture retention and comfort depend not only on prosthetic design and tissue adaptation, but also on the presence of an adequate salivary film at the mucosa–prosthesis interface. Saliva contributes to adhesion, cohesion, lubrication, bolus formation, mucosal


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protection, and microbial clearance. Therefore, even modest reductions in salivary flow may have disproportionate clinical consequences in complete or partial denture wearers. Previous studies have shown that salivary parameters can be modified in denture patients through topical or prosthesis-associated interventions, supporting the clinical rationale for measuring salivary flow in this population [1]. Recent reviews also emphasize that salivary dysfunction may directly affect denture retention, mucosal tolerance, and patient-perceived prosthetic performance [2,7].

The baseline differences observed in the present pilot sample are consistent with the distinction between xerostomia and hyposalivation. Patients without xerostomia presented unstimulated salivary flow values compatible with physiological secretion, whereas patients with xerostomia showed markedly reduced baseline flow. This finding is clinically relevant because subjective dryness does not always perfectly overlap with objective salivary reduction. Nevertheless, in the current sample, high xerostomia VAS scores coincided with low unstimulated salivary flow values, supporting the internal consistency of group allocation. Previous evidence indicates that xerostomia and salivary flow may influence adaptation to conventional complete dentures and patient satisfaction with removable denture performance [3,4]. In this context, the combination of subjective xerostomia assessment and objective sialometry appears preferable to either measure alone.

The modest increase observed after water rinsing suggests that simple oral hydration or mechanical rinsing may transiently improve oral moisture, but has limited capacity to stimulate salivary output. By contrast, honey-based stimulation produced a more evident salivary response. This effect is biologically plausible because sweet gustatory stimuli activate salivary reflex pathways, particularly when functional salivary gland tissue remains responsive. The proportionally greater increase observed in xerostomic patients may reflect a low baseline effect, where even a modest absolute gain translates into a large relative change. However, the lower final stimulated values in this group indicate that the secretory reserve remains limited. This distinction between relative and absolute response is important because clinical benefit depends not only on percentage increase but also on whether the achieved salivary flow is sufficient to improve lubrication, denture comfort, and mucosal protection.

These studies suggest that honey-based rinses may improve subjective dryness and salivary-related parameters. However, those populations differ from removable denture wearers, and the mechanisms relevant to prosthetic patients are more complex. In denture wearers, any topical agent must be considered not only in relation to salivary stimulation, but also in terms of prosthetic surface interaction, residual sugar exposure, plaque accumulation, Candida colonization, and mucosal tolerance. For this reason, the present protocol included expectoration and a final water rinse to reduce prolonged sugar contact with oral and prosthetic surfaces.

The relationship between salivary dysfunction and the prosthetic oral ecosystem is clinically important. Removable dentures, particularly PMMA-based prostheses, create retentive surfaces that may facilitate biofilm formation. Changes in salivary pH, reduced cleansing capacity, and altered mucosal lubrication may further modify the local environment [13]. Candida colonization has been reported in patients with different prosthetic appliances, and denture stomatitis is widely recognized as a multifactorial condition involving denture biofilm, mucosal trauma, nocturnal denture wearing, host factors, and microbial virulence [5,14,15]. Saliva has a protective role through mechanical


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clearance, antimicrobial proteins, buffering capacity, and maintenance of mucosal integrity. Therefore, reduced salivary flow may contribute indirectly to Candida persistence and denture-related inflammation, especially in older or medically compromised patients [16-18].

The inclusion of salivary dysfunction in the discussion of oral candidiasis is further supported by recent evidence linking aging, salivary hypofunction, and oral candidiasis in stomatitis patients [19]. This is highly relevant for removable denture wearers, who often belong to older age groups and may present polypharmacy, systemic disease, reduced manual dexterity, and compromised denture hygiene. In such patients, the clinical effect of salivary stimulation should not be interpreted only as a quantitative increase in mL/min but also as a potential contributor to improved oral lubrication, reduced mucosal friction, enhanced clearance, and possibly a less favorable environment for opportunistic fungal overgrowth. Nevertheless, the present study did not include microbiological sampling, and therefore no conclusions can be drawn regarding Candida burden or antifungal effects.

The findings also need to be interpreted in relation to current xerostomia management strategies. Artificial saliva and saliva substitutes are commonly used for symptomatic relief, but they do not fully reproduce the biological, enzymatic, antimicrobial, and rheological properties of natural saliva [20]. In contrast, gustatory stimulation attempts to activate endogenous salivary secretion, which may be clinically advantageous when residual glandular function is preserved. The present pilot data support this concept, particularly in patients P4 and P6, who showed more pronounced responses after honey-based stimulation. Patient P5, who had the lowest baseline flow, showed a smaller absolute response, suggesting that the effectiveness of gustatory stimulation may depend on remaining glandular reserve. This observation is consistent with the general clinical principle that stimulants are more useful in partial salivary dysfunction than in severe irreversible glandular impairment.

From a clinical perspective, the protocol appears simple, inexpensive, and well tolerated. No immediate adverse reactions were reported, and patients with xerostomia described transient subjective improvement in oral moisture. This tolerability profile is relevant because xerostomic denture wearers often require repeated, accessible, and patient-acceptable strategies to improve comfort. However, honey contains fermentable carbohydrates, and this represents a potential limitation in dentate or partially dentate patients, particularly those with high caries risk, poor oral hygiene, diabetes, or reduced capacity to perform denture cleaning. Therefore, honey-based stimulation should not be presented as a universal treatment for xerostomia, but rather as an experimental gustatory stimulation approach requiring careful patient selection, controlled exposure time, expectoration, post-procedure rinsing, and reinforcement of oral and prosthetic hygiene.

The present study has several limitations. The sample size was very small, and the design was exploratory; therefore, no inferential conclusions can be drawn. The absence of randomization, blinding, long-term follow-up, microbiological assessment, and comparison with established salivary stimulants limits the strength of interpretation. The response was measured only immediately after stimulation, so the duration of the effect remains unknown. In addition, the composition of natural honey may vary according to botanical source, processing, viscosity, sugar profile, and bioactive compounds, which could influence reproducibility. Future studies should include larger samples, standardized honey formulations, crossover comparison with sugar-free gustatory stimulants or


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commercial saliva substitutes, longer observation intervals, xerostomia questionnaires, denture satisfaction scores, mucosal indices, salivary pH, buffering capacity, and Candida quantification.

Despite these limitations, the present pilot study provides a clinically coherent proof-of-concept. It shows that honey-based gustatory stimulation can produce an immediate salivary flow response in removable denture wearers, including those with xerostomia-associated hyposalivation. The findings support further investigation of simple, topical, patient-friendly stimulation protocols in prosthetic populations, while emphasizing the need for controlled validation before clinical recommendations can be made.

## 5. Conclusions

Within the limitations of this pilot interventional case-series, honey-based gustatory stimulation produced an immediate and measurable increase in whole salivary flow in removable denture wearers, both in patients with physiological baseline salivation and in those with xerostomia-associated hyposalivation. Although the relative salivary response was greater in xerostomic patients, their post-stimulation flow values remained below those observed in participants without xerostomia, suggesting that the effect depends on residual salivary gland function rather than full restoration of normal secretion. The protocol was simple, well tolerated, and associated with transient subjective improvement in oral moisture, supporting its potential as an exploratory adjunctive approach for xerostomic denture wearers. However, because of the very small sample size and the short-term nature of the assessment, these findings should be interpreted as preliminary and hypothesis-generating. Larger controlled studies are required to determine the duration of the salivary response, clinical impact on denture comfort and mucosal tolerance, and safety profile of repeated honey-based stimulation in prosthetic patients.

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