Taste Assessment Protocol: A New Simple Way of Testing Taste

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Abstract

Background: The objective of this work was to describe a simple, economical, and reproducible method for taste evaluation.

Methods: A new protocol called Taste Assessment Protocol was created using different concentrations of sweet, salty, bitter, and sour solutions. The test was applied to participants complaining of persistent olfactory–gustatory complaints after coronavirus disease 2019 diagnosis.

Results: Ten participants were included. The mean Taste Assessment Protocol score was 10.75 ± 1.2, with a recorded minimum of 8 and a recorded maximum of 12. Ninety percent of the patients had a Taste Assessment Protocol score ≥ 10. The mean olfactory threshold of the observed patients was 3.5 ± 1.7, with a registered minimum of 2 and a maximum of 6.

Conclusion: Tests like this may persuade researchers and clinicians to assess taste more regularly. Validation of this method could bring light to a standardized and easily applicable taste test, with a well-defined score. Taste assessment by this method suggests that gustatory dysfunction after coronavirus disease 2019 may be due to retronasal olfactory dysfunction.

Keywords: COVID-19, economical, simple test, Taste Assessment Protocol (TAP) score, taste examination

INTRODUCTION

The chemical detection of tastants is useful in various patient groups and for a multitude of underlying pathologies. For patients complaining of taste dysfunction (TD), a thorough assessment of both gustatory and olfactory function is warranted, as it might be troublesome to differentiate gustatory deficits from olfactory impairments.[1,2] Dysgeusia can be a symptom or a common consequence of several causes.[3] Taste dysfunction can arise due to infections, medicinal side effects, alterations in saliva production, secondary to systemic diseases, or after cancer radiotherapy.[1,4-10]

Validated kits for the assessment of taste function are expensive and involve continuous costs due to the perishability of their components. This may contribute determinately for the deterrence in their use. In daily practice, economical, practical, and accessible instruments for the assessment of taste may be advantageous for the clinicians who are dedicated to this area. The objective of this work is the development and application of an affordable and accessible method for testing gustatory function. This protocol does not intend to replace the more traditional elements of formal assessment. It was in turn created by our team in order to foment basic taste testing when clinically applicable. The authors decided to call it Taste Assessment Protocol (TAP).

METHODS

In order to obtain a reproducible test for use in clinical practice, the authors performed a primary literature search. Basing on a protocol produced by Douglas et al[11] validated for the study of gustatory function, the authors created their own test. The test consists of 12 bottles of 300 mL with 4 different tastes in variable concentrations. The bottles were divided into 4 groups: sweet group, consisting of 3 bottles of sugar water in varying concentrations; salty group, consisting of 3 bottles of salt water in varying concentrations; bitter group, consisting of 3 bottles of water with quinine in varying concentrations; and sour group, consisting of 3 bottles of water with natural lemon juice in varying concentrations. The investigators tested the functional applicability of the protocol prior to its clinical implementation by asking normal subjects to detect minimal perceivable concentrations of solutes in the 300 mL of water.

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Bottle 1	50g of white sugar in 300 ml of mineral/distilled water
Bottle 2	10 ml of lemon juice in 300 ml of mineral/distilled water
Bottle 3	50 ml of tonic water Schweppes® (67.9 mg/L of quinine) in 250 ml of mineral/ distilled water
Bottle 4	10 g of salt in 250 ml of mineral /distilled water
Bottle 5	10 g of white sugar in 300 ml of mineral /distilled water
Bottle 6	50 g of salt in 250 ml of mineral /distilled water
Bottle 7	2 ml of lemon juice in 300 ml of mineral/distilled water
Bottle 8	100 ml of tonic water Schweppes® (67.9 mg/L of quinine) in 200 ml of mineral/distilled water
Bottle 9	25 g of white sugar in 300 ml of mineral/distilled water
Bottle 10	25 g de of salt in 250 ml of mineral/distilled water
Bottle 11	150 ml of tonic water Schweppes® (67.9 mg/L of quinine) in 150 ml of mineral/distilled water
Bottle 12	5 ml of lemon juice in 300 ml of mineral/distilled water

Figure 1. Instructions for Taste Assessment Protocol (TAP) test preparation.

Minimal perceived concentrations in normal subjects were then used to make additional variations of increasing concentration. Figure 1 presents instructions for TAP preparation, Figure 2 TAP administration and scoring instructions, and Figure 3 TAP annotation sheet.

With the view of examining the potential for application of the test in a real clinical scenario, patients from a parallel post-coronavirus disease 2019 (COVID-19) olfactory dysfunction (OD) investigation and who had subjectively referred olfactory–gustatory complaints were recruited. Taste Assessment Protocol was then applied in the study of patients with complaints of subjective olfactory–gustatory dysfunction after COVID-19. In the same patients, olfactory thresholds were also measured using Sniffin sticks® with n-butanol.

Informed consent was obtained for all patients. The study was approved by the local Ethics Committee (Number: 2021.93 [075-DEFI/078-CE]), and the design complies with the Declaration of Helsinki ethical standards. Statistical analysis was performed using Statistical Package for the Social Sciences version 26.0 software (IBM Corp.; Armonk, NY, USA). In the descriptive analysis, categorical variables are presented as percentages, and continuous variables as means and standard deviations.

RESULTS

The test was applied to 10 participants, 6 females and 4 males, with subjective complaints of altered taste after a confirmed diagnosis of COVID-19. Mean age at COVID-19 diagnosis was 45.75 ± 14 years. The

1) Prepare 12 test disposable plastic cups and 1 "cleaning" cup.
2) Fill each cup with the numbered bottle solution one at a time by the order of 1 to 12.
3) Ask the patient to gargle the different solutions by the order of 1 to 12.
4) Between each solution, ask the patient to use the "cleaning" cup to mouthwash.
5) Ask the patient to indicate the taste of each of the 12 solutions and register the answers in the sheet.
6) Calculate the score

Identification/Discrimination (taste quality): number of correct answers (from 0-12)

Threshold (taste intensity):
Sweet – number of correct answers in the bottles 1 + 5 + 9 (zero to three)
Salty - number of correct answers in the bottles 4 + 6 + 10 (zero to three)
Bitter - number of correct answers in the bottles 3 + 8 + 11 (zero to three)
Sour – number of correct answers in the bottles 2 + 7 +12 (zero to three)

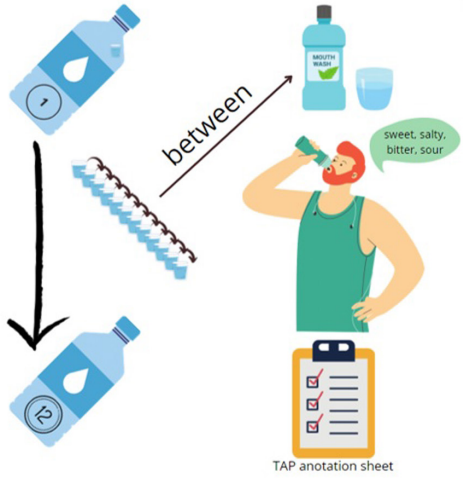
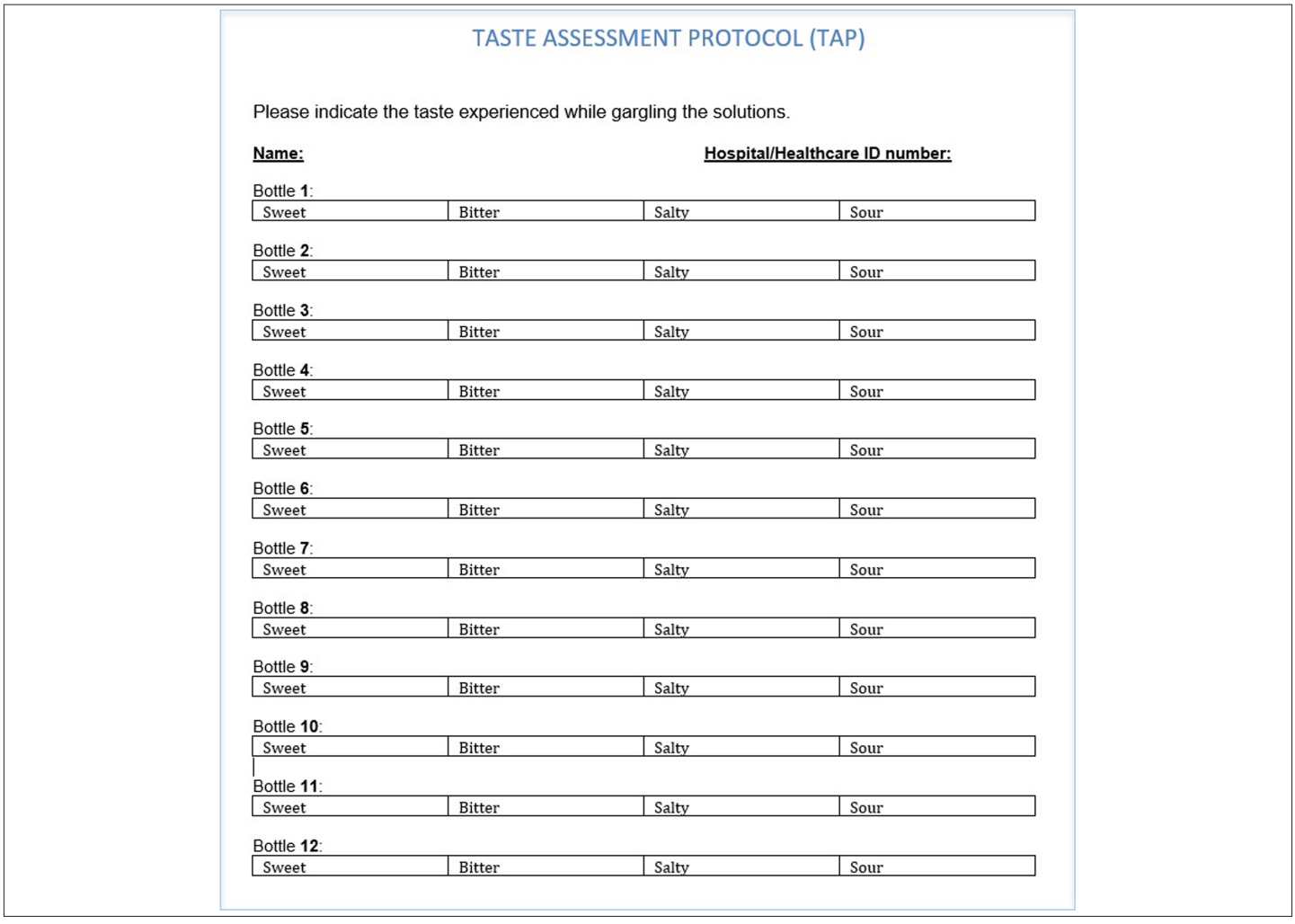


Figure 2. Taste Assessment Protocol (TAP) administration instructions and scoring.



TASTE ASSESSMENT PROTOCOL (TAP)

Please indicate the taste experienced while gargling the solutions.

Name: **Hospital/Healthcare ID number:**

Bottle **1**:			
Sweet	Bitter	Salty	Sour
Bottle **2**:			
Sweet	Bitter	Salty	Sour
Bottle **3**:			
Sweet	Bitter	Salty	Sour
Bottle **4**:			
Sweet	Bitter	Salty	Sour
Bottle **5**:			
Sweet	Bitter	Salty	Sour
Bottle **6**:			
Sweet	Bitter	Salty	Sour
Bottle **7**:			
Sweet	Bitter	Salty	Sour
Bottle **8**:			
Sweet	Bitter	Salty	Sour
Bottle **9**:			
Sweet	Bitter	Salty	Sour
Bottle **10**:			
Sweet	Bitter	Salty	Sour
Bottle **11**:			
Sweet	Bitter	Salty	Sour
Bottle **12**:			
Sweet	Bitter	Salty	Sour

Figure 3. Taste Assessment Protocol (TAP) annotation sheet.

mean time between taste dysfunction onset and TAP assessment was 326 ± 162 days. The mean TAP score was 10.75 ± 1.2, with a recorded minimum of 8 and a recorded maximum of 12. Ninety percent of the patients had a TAP score ≥ 10. The mean olfactory threshold of the observed patients was 3.5 ± 1.7, with a minimum recorded from 2 and a maximum of 6, confirming olfactory alteration in all cases. Table 1

Table 1. Description of Participants and Main Findings

					TAP Thresholds			
Age	Gender	Comorbidities	Olfactory Threshold	TAP Score (Total)	Sweet	Salty	Bitter	Sour
21	Male	None	4	11	3	3	2	3
29	Male	None	3	12	3	3	3	3
39	Female	Asthma	5	11	3	3	2	3
43	Male	None	6	11	2	3	3	3
47	Female	Lupus	3	10	2	3	2	3
48	Female	Hypertension Asthma	3	12	3	3	3	3
49	Female	Hypothyroidism	4	11	3	2	3	3
59	Male	None	3	12	3	3	3	3
60	Female	Hypertension	2	10	2	3	2	3
63	Female	Diabetes mellitus Dislipidemia	2	8	3	2	0	3

TAP, Taste Assessment Protocol.

summarizes the findings of this pilot application of TAP in post-COVID-19 gustatory complaints.

DISCUSSION

Adequate taste sensation has major implications in daily live, acting as a regulator of food ingestion.[1] On one hand, bitter, salty, and sour tastes elicit taste defensive and protective mechanisms to prevent the ingestion of potentially noxious foods and to assure internal sodium or acid–base balance.[12] On the other hand, sweet foods are naturally pleasurable since carbohydrates serve as the main energy source for animals. Lastly, umami senses amino acids in proteins, which naturally occur in meats, vegetables, and fermented products that are essential for humans.[13] Impairment of such normal gustatory functioning may therefore impair eating habits.[1] A variety of factors including genetics, nutrition, biology, environment, and viral illness may associate with altered taste.[1]

Taste dysfunction and chemosensory dysfunction in general have also emerged as prominent symptoms of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) infection in the current COVID-19 pandemic, raising awareness of the importance of this primordial sense.[1] There is no consensus about the real impact of SARS-CoV-2 infection and TD. On one hand, many studies evoke potential direct mechanisms for post-COVID-19 dysgeusia,[14] and a recent meta-analysis concluded for objective post-COVID-19 TD in about 37% of the evaluated patients.[15] Nevertheless, other works reveal OD with preserved gustation in COVID-19, suggesting that TD is a result of retronasal OD alone and therefore not a result of a real taste impairment.[16] In this matter, our results are in line with the former formulation: patients revealed an objective OD measured by olfactory thresholds, with an otherwise normal TAP test, despite complaining of TD.

In the last years, the emergence of the COVID-19 pandemic was accompanied by an outbreak of olfacto–gustatory complaints in the otorhinolaryngology (ORL) clinic.[17] This reinforced the pertinence of having adequate objective methods of smell and taste evaluation in ORL departments. Making olfactory–gustatory diagnostic arsenal available for the clinician is probably a current concern in some contexts due to the inherent high costs of such materials. Nevertheless, as the smell and gustatory function can have significant consequences for the treatment and care of patients, it is important to use both reachable and accurate assessment methods.

The most commonly used measurement of gustatory function is the recognition threshold. Several tests have been constructed to estimate this measure of gustatory sensitivity. Two of the most used and well-validated methods are "Taste Strips"[18-20] and liquid tastant drop tests.[21,22] Both gustatory test types have their advantages and disadvantages. The "Taste Strips" are easy and fast to apply and have a long shelf life. However, the "Taste Strips" are expensive compared to liquid drop tests, and the difference in dilution steps varies across tastants. The liquid taste drop tests are possible to prepare with a minimum of laboratory equipment; however, the current versions of liquid taste drop tests suffer with uneven dilution steps between the different tastants.[21] In order to accurately test changes in peripheral gustatory function, a sensitive and reliable gustatory test is warranted.

In the attempt to overcome the need for a cheap, simple, reliable, and reproducible test, amenable to be used in clinical practice, our team developed TAP. The fact that TAP includes rinsing solutions may enhance reliability due to the fact that all areas of the oropharynx are actually being tested. On the other hand, TAP measures both discrimination and identification (by total TAP score), as well as gustatory thresholds (3 levels). In TAP, opposingly to other widely used tests of chemosensory thresholds,[23] the test administrator may be blinded to the correctness of the response, as the knowledge of correctness is not a prerequisite to follow the stepwise approach to determine tastant threshold. We proposedly blinded the test by introducing numbered tastant containers unknown to both the test administrator and participant, until the moment of scoring where the concentration sheet is consulted. The investigator could therefore easily be blinded to the containers if not involved in their preparation. However, if used in this way, this renders a stepwise decrease/increase of tastant concentration impossible. In the case that threshold detection is the main objective, one can also use the TAP test along with the concentration sheet (Figure 1) in order to detect specific taste thresholds if needed. The same 300 mL preparations can be used to test multiple patients and be stored up to a week in the refrigerator.

Besides the obvious advantages of this method, there are pitfalls to point out. This is mainly a pilot study. This method has not yet been validated robustly against traditional methods of taste testing and in other patient populations. The authors believe in its potential and expect that it can be useful to those who find this contribution valuable. If appropriately validated, it could be used routinely in the evaluation of patients with complaints of gustatory dysfunction in the future.

CONCLUSION

Tests like TAP could persuade researchers and clinicians to assess taste more regularly, making the testing of taste function more appealing and widely used. Most of the evaluated patients with complaints of olfactory–gustatory dysfunction after COVID-19 had objective hyposmia thresholds but did not appear to have gustatory dysfunction as measured by TAP. It is thus possible that the referred gustatory dysfunction was perceived due to retronasal olfactory dysfunction. It would be pertinent to access the validity of TAP by comparing normal subjects against patients with other causes of real known taste disturbances, such as post-radiotherapy of the head and neck.

Ethics Committee Approval: The study was approved by the medical ethics committee of Centro Hospitalar Universitário do Porto (No: 2021.93 [075-DEFI/078-CE]).

Informed Consent: Written informed consent was obtained from the patients who participated in this study.

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Declaration of Interests: The authors have no conflict of interest to declare.

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