Evaluation of Regional Taste Function in Healthy Thai Subjects Using Standard Suprathreshold Tastants

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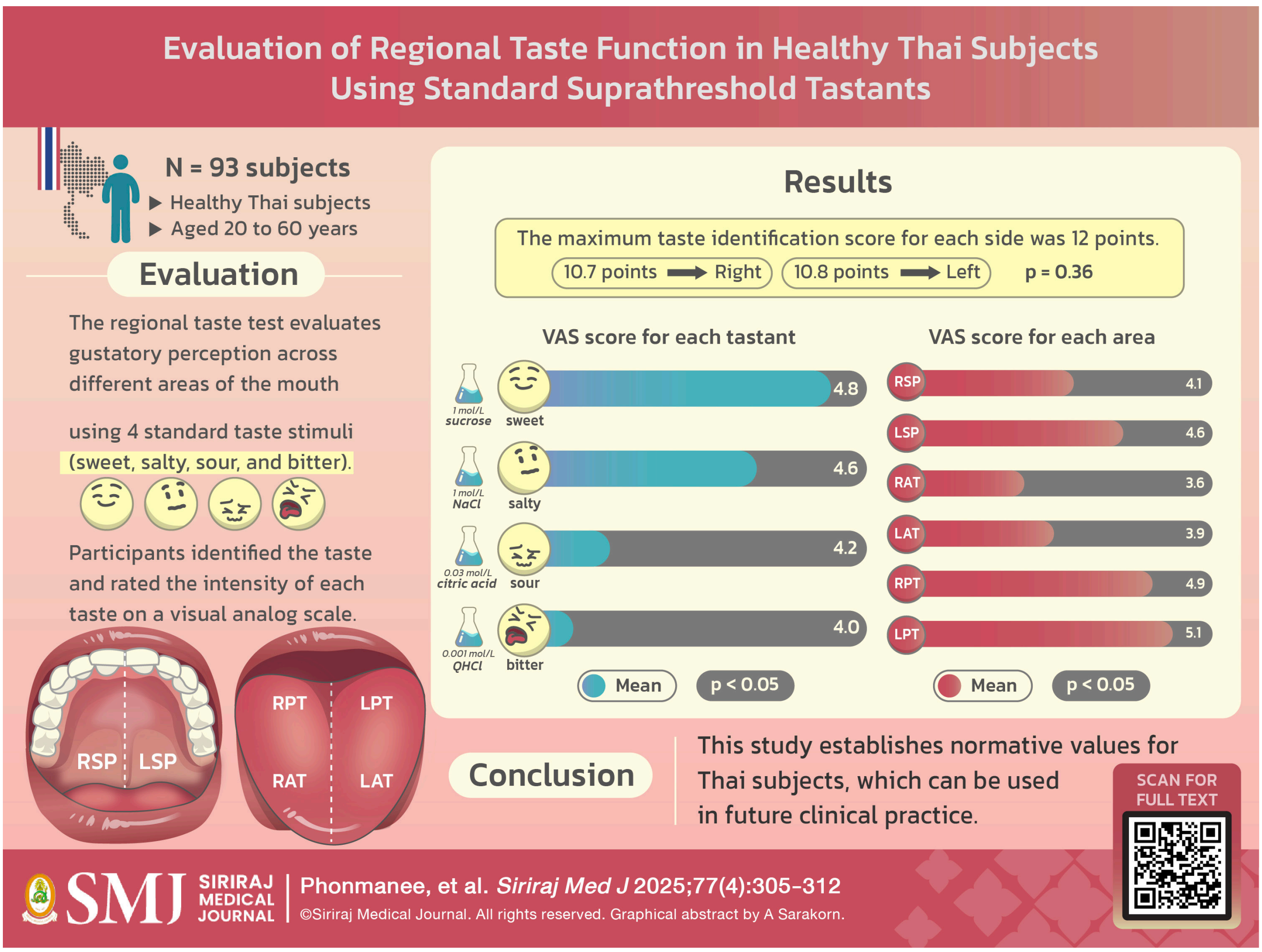

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ABSTRACT

Objective: To evaluate regional taste function in normal Thai subjects using standard suprathreshold tastants.

Materials and Methods : A total of 93 healthy Thai subjects (41 males and 52 females), aged 20 to 60 years, were recruited. Regional taste function was assessed using four standard suprathreshold tastants, with both identification scores and VAS scores recorded.

Results: The mean total taste identification score was 10.7 on the right side and 10.8 on the left side, with no statistically significant differences between sides across all subgroups. The mean VAS score was highest for sweet tastants and for the posterior tongue as the tested area. No significant differences were observed between sexes or among age groups when analyzed by tastant and area.

Conclusion: The regional (spatial) taste test is a useful gustatory test. This study establishes normative values for Thai subjects, which can be used in future clinical practice for patient evaluations.

Keywords: Regional taste test; spatial taste test; gustatory test; gustatory function (Siriraj Med J 2025; 77: 305-312)

INTRODUCTION

Taste is an important sensory function, as it helps stimulate appetite, identify food components, and detect toxic substances. Several factors can lead to taste dysfunction, including infections, systemic health conditions, poor oral hygiene, prior surgeries, radiation exposure, head injuries, or aging.[1,2] The four basic taste categories are salty, sweet, sour, and bitter, with umami (savory flavor) also proposed as a distinct taste.[1] The prevalence of taste dysfunction has been reported to range from 0.6% to 20%.[3] Loss of taste can have numerous adverse effects, including reduced appetite, weight loss, and psychological issues such as depression.[4,5] Studies have shown that taste dysfunction can significantly impact a patient's quality of life.[4,6] However, patients often cannot identify taste loss and frequently confused olfactory loss with gustatory loss.[4] Furthermore, self-reported taste assessments via questionnaires tend to have low sensitivity and specificity compared to objective taste tests.[7] Localized taste loss is especially hard to detect, as it may lack clear symptoms and is often compensated for by other areas.[8]

Assessing taste function is technically challenging and time-consuming. The two primary types of chemical taste testing are detection threshold tests and regional (spatial) taste tests. This study focuses on regional taste tests in normal Thai subjects, targeting areas innervated by the chorda tympani branch of the facial nerve (anterior tongue), the glossopharyngeal nerve (posterior tongue), and the greater superficial petrosal nerve (soft palate).[6] Data on taste testing in Thailand and Southeast Asian countries are limited, particularly regarding regional taste assessments. The results of this study will provide a valuable reference for regional taste testing in Thai clinical settings.

MATERIALS AND METHODS

A total of 93 healthy Thai subjects (41 males, 52 females) aged between 20 and 60 were recruited. Subjects were required to refrain from eating food, except water, for at least one hour before testing. Subjects with conditions that could affect taste and smell function, such as tongue lesions, a history of tongue surgery or cranial nerve-related surgeries, sinonasal diseases, smoking, or those taking medications that could affect taste function, were excluded from the study. Alcohol consumption status and dietary habits were not part of the exclusion criteria.

The study protocol and consent procedures received ethical approval from the Siriraj Institutional Review Board (COA No. Si 676/2012). All subjects provided documented informed consent before participating in the study.

Test procedures

The regional (spatial) taste function test was adapted from the test developed by the Connecticut Chemosensory Clinical Research Center (CCCRC).[8] The test evaluated six areas: the right and left anterior tongue, posterior tongue, and soft palate, as shown in Fig 1. The liquid taste solutions and concentrations used were 1 mol/L sodium chloride (NaCl) for salty, 1 mol/L sucrose for sweet, 0.03 mol/L citric acid for sour, and 0.001 mol/L quinine hydrochloride (QHCl) for bitter,[8] all at suprathreshold concentrations.

Each taste solution was applied to the six areas using a sterile cotton swab in a random order, resulting in 24 tests. Participants identified the taste as salty, sweet, sour, or bitter, earning a score of 1 for each correct response, with a maximum score of 12 per side of the tongue. Subjects also rated the intensity of each taste on

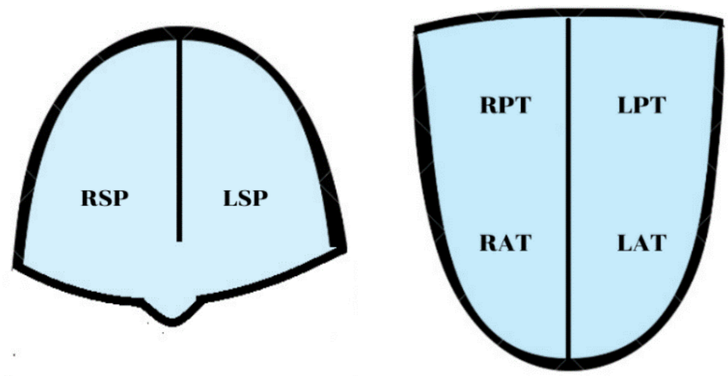

Fig 1. Images showing the tested palate and tongue areas. The labeled areas are where the four tastants were applied.
RSP=right soft palate, LSP=left soft palate, RPT= right posterior tongue, LPT=left posterior tongue, RAT=right anterior tongue, LAT=left anterior tongue (Drawing by Tharatham Phonmanee)

a visual analog scale from 0 to 10, with a higher score reflecting stronger intensity. Between tests, participants rinsed their mouths to minimize carryover effects. All tests were conducted by a single investigator to eliminate inter-rater variability.

Statistical analysis

All statistical analyses were performed using SPSS Statistics version 15.0 (SPSS Inc., Chicago, IL, USA). Paired t-tests were conducted to compare differences between the right and left sides of the mouth. Repeated measures ANOVA was used to analyze differences in VAS scores among taste stimuli and regions. The chi-square test was used to assess statistical differences in the percentage of acceptable taste identification between sexes and across age groups. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 93 subjects participated in the study (mean age 41.6 ± 11.6), comprising 41 males (mean age 40.8 ± 11.3 years) and 52 females (mean age 42.1 ± 11.9 years). Regional taste function testing was performed in six areas using the four basic taste solutions as described earlier. The maximum taste identification score for each side was 12 points. Mean scores for each sex and age group are presented in Table 1. No statistically significant differences were found between the mean scores for each side of the mouth.

Taste identification was deemed acceptable if participants correctly identified the taste in at least five out of six areas of the tongue. The proportion of acceptable taste identification for each taste is shown in Table 2. No statistically significant differences in taste identification ability were observed based on sex and age group.

The mean VAS score for each taste across all six areas is shown in Table 3. Differences in VAS scores among the tastes were statistically significant for the total participant group as well as the male and female subgroups (p <0.05). The mean VAS score was highest for sweet, followed by salty, sour, and bitter, respectively.

Taste identification by area was analyzed, with results shown in Table 4. Acceptable taste identification was defined as correctly identifying at least three of the four basic taste stimuli in each area of the mouth. No statistically significant differences in taste identification ability by sex or age group were observed for any area. The mean VAS score differed significantly among the areas, with the posterior tongue recording the highest mean VAS score, followed by the soft palate and anterior tongue, respectively (Table 5 and Fig 2).

DISCUSSION

Clinical evaluation of taste function is not a routinely performed test. Various methods exist for assessing taste, including self-ratings of taste function, chemical stimuli tests, and electrical stimuli tests (also known as electrogustometry).[9,10] Chemical stimuli tests are commonly divided into whole-mouth and regional testing. These tests typically involve the four basic taste qualities: salty, sweet, sour and bitter. However, specific taste substances and concentrations vary among institutions. Taste tests are generally categorized as threshold tests and suprathreshold tests based on the concentrations of tastants. The application methods depend on the target area being tested, such as the right and left sides of the tongue, the tip/anterior and posterior sections, the four quadrants of the tongue, or areas of the tongue in conjunction with the palatal region. Different tools are used to deliver tastants, including cotton swabs, paper discs, edible wafers, taste strips, and solutions.[9-12]

This study focuses on regional taste testing and provides normative data for Thai subjects. The technique and concentrations used at Siriraj's Smell & Taste Clinic

TABLE 1. Total taste identification scores for each side of the mouth.

	Number of subjects (%)	Mean ± SD		p-value
		Right	Left	
Total	93 (100.0)	10.7±1.7	10.8±1.5	0.36
Sex:				
Male	41 (44.1)	10.6±1.7	10.7±1.6	0.44
Female	52 (55.9)	10.8±1.7	10.9±1.5	0.58
Age:				
20-29	19 (20.4)	11.0±1.2	10.9±1.3	0.87
30-39	23 (24.8)	10.8±1.7	11.0±1.3	0.55
40-49	20 (21.5)	10.4±2.0	10.5±1.8	0.51
50-59	31 (33.3)	10.8±1.8	10.9±1.7	0.42

TABLE 2. Proportion of acceptable taste identification by each taste stimulus (the taste is correctly identified in at least five out of six areas).

	Number of subjects (%)			
	Salty	Sweet	Sour	Bitter
Total	81 (87.1)	90 (96.8)	71 (76.3)	75 (80.6)
Sex:				
Male	36 (87.8)	41 (100.0)	30 (73.2)	33 (80.5)
Female	45 (86.5)	49 (94.2)	41 (78.8)	42 (80.8)
p-value	0.97	0.25	0.52	0.86
Age:				
20-29	18 (94.7)	18 (94.7)	16 (84.2)	14 (73.7)
30-39	20 (87.0)	22 (95.7)	17 (73.9)	20 (87.0)
40-49	16 (80.0)	20 (100.0)	14 (70.0)	14 (70.0)
50-59	27 (87.1)	30 (96.8)	24 (77.4)	27 (87.1)
p-value	0.34	0.89	0.76	0.62

TABLE 3. Mean VAS score for the four tastants (salty, sweet, sour, and bitter).

	Mean ± SD				p-value
	Salty	Sweet	Sour	Bitter	
Total	4.6±2.1	4.8±2.0	4.2±1.9	4.0±1.9	<0.05*
Sex:					
Male	4.3±2.1	4.4±2.1	3.7±1.9	3.4±1.6	<0.05*
Female	4.9±2.1	5.0±1.8	4.6±1.7	4.3±2.1	<0.05*
Age:					
20-29	5.9±2.2	5.1±2.4	4.5±1.9	4.5±2.3	<0.05*
30-39	5.1±2.1	5.3±1.9	4.6±2.2	4.6±1.8	0.16
40-49	4.4±1.9	4.7±1.8	4.1±1.6	3.5±1.4	<0.05*
50-59	3.6±1.8	4.1±1.7	3.8±1.8	3.4±1.9	0.06

TABLE 4. Proportion of acceptable taste identification in each area of the mouth (at least three out of four basic tastes are correctly identified in that area).

	Number of subjects (%)					
	RSP	LSP	RAT	LAT	RPT	LPT
Total	87 (93.5)	87 (93.5)	80 (86.0)	77 (82.8)	88 (94.6)	88 (94.6)
Sex:						
Male	36 (87.8)	38 (92.7)	36 (87.8)	34 (82.9)	39 (95.1)	39 (95.1)
Female	51 (98.1)	49 (94.2)	44 (84.6)	43 (82.7)	49 (94.2)	49 (94.2)
p-value	0.08	1.00	0.66	0.98	1.00	1.00
Age:						
20-29	18 (94.7)	18 (94.7)	17 (89.5)	16 (84.2)	19 (100.0)	19 (100.0)
30-39	22 (95.7)	22 (95.7)	19 (82.6)	21 (91.3)	23 (100.0)	22 (95.7)
40-49	17 (85.0)	19 (95.0)	17 (85.0)	14 (70.0)	18 (90.0)	18 (90.0)
50-59	30 (96.8)	28 (90.3)	27 (87.1)	26 (83.9)	28 (90.3)	29 (93.5)
p-value	0.44	0.94	0.92	0.36	0.26	0.64

Abbreviations: RSP=right soft palate, LSP=left soft palate, RAT=right anterior tongue, LAT=left anterior tongue, RPT= right posterior tongue, LPT=left posterior tongue

TABLE 5. Mean VAS score for each area of the mouth.

	Mean ± SD						p-value
	RSP	LSP	RAT	LAT	RPT	LPT	
Total	4.1±1.8	4.6±1.9	3.6±1.8	3.9±1.7	4.9±2.2	5.1±2.1	<0.05*
Sex:							
Male	3.6±1.8	4.2±2.0	3.2±1.4	3.5±1.6	4.5±2.2	4.7±2.2	<0.05*
Female	4.5±1.7	4.9±1.8	4.0±2.0	4.2±1.7	5.3±2.2	5.5±2.0	<0.05*
Age:							
20-29	4.5±1.8	5.4±2.3	4.3±2.3	4.5±2.0	5.6±2.4	5.8±2.2	<0.05*
30-39	4.7±1.9	5.1±1.8	4.2±1.5	4.5±1.8	5.1±2.1	5.8±2.2	<0.05*
40-49	3.7±1.6	4.3±1.7	3.4±1.1	3.8±1.2	5.1±2.1	4.9±1.6	<0.05*
50-59	3.8±1.7	4.0±1.8	2.9±1.7	3.1±1.3	4.3±2.3	4.4±2.1	<0.05*

Abbreviations: RSP=right soft palate, LSP=left soft palate, RAT=right anterior tongue, LAT=left anterior tongue, RPT= right posterior tongue, LPT=left posterior tongue

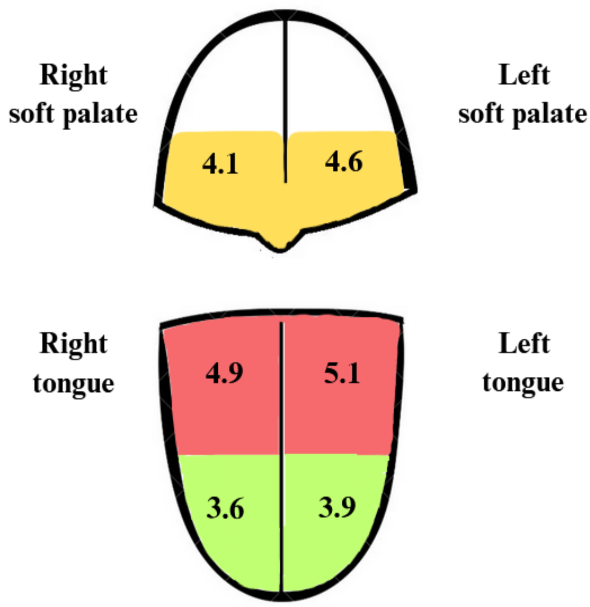

Fig 2. Images showing the mean VAS score for each tested palate and tongue area.
(Drawing by Tharatham Phonmanee)

are adapted from the CCCRC spatial taste test.[8] The main advantage of regional taste testing over whole-mouth tests is its ability to localize specific lesions. Taste buds are primarily located on the tongue but are also found on the soft palate, pharynx, and epiglottis, with taste receptors distributed across other organ systems.[13,14] The nerves that innervate each area of the tongue vary based on the location and types of taste papillae; the anterior tongue contains fungiform papillae and is innervated by the chorda tympani nerve, a branch of the facial nerve; the posterior tongue contains circumvallate and foliate papillae and is innervated by the glossopharyngeal nerve; and the soft palate is innervated by the greater superficial petrosal nerve, which is also a branch of the facial nerve.[13] Regional taste tests can detect specific nerve dysfunctions such as chorda tympani nerve injury after middle ear surgery, which whole-mouth tests may miss. A study by *Matsuda et al.*[15] demonstrated regional taste dysfunction in elderly subjects for NaCl.

As there is no standard cut-off point for correct taste identification, we used a threshold of five out of six areas as the passing level for each taste. With these concentrations, over 70% of subjects passed for each taste stimulus. Subjects rated sweet as the strongest taste overall on the VAS. While intensity ratings for sour tend to be the highest in other studies, comparisons with our findings are not possible due to differences in testing techniques and concentrations.[4,16] The trend of high VAS scores for sweet may influence the consumption of sweet foods and drinks among Thai people; however, further studies on this topic are needed.

By area, over 80% of subjects could identify at least three out of the four basic tastes. The posterior tongue recorded the highest average VAS scores, followed by the soft palate and anterior tongue. The glossopharyngeal nerve carries special visceral afferent fibers from the posterior third of the tongue. The neural pathway passes through the inferior ganglion, then through the jugular foramen to the nucleus solitarius, and continues to other brain areas.[17] The difference in taste sensation across various areas is suggested to be caused by the number of taste buds and nerves that are stimulated.[18] Previous studies on regional taste sensitivity have yielded conflicting findings, with many reporting taste sensitivity varies by stimulus across different areas. *Nilsson et al.*[19] reported higher taste thresholds on the soft palate compared to the tongue. *Collings et al.*[20] found that NaCl had the lowest threshold on the anterior tongue and the highest on the soft palate. Similarly, sucrose had the lowest threshold on the anterior tongue but the highest on the sides, while quinine had the lowest threshold on the soft palate. Another study by *Feeney et al.*[21] found higher intensity ratings for bitter and umami on the posterior tongue compared to the anterior tongue. *Sato et al.*[18] reported no differences in thresholds for sweet, salty, and bitter across regions, but sour thresholds were higher on the soft palate than on the tip of the tongue.

Previous studies have shown that older age is associated with decreased taste perception.[16,22,23] However, our study found no significant differences in taste identification ability across age groups when analyzed by individual taste stimuli and areas of the tongue. This may be because the inclusion criteria limit the maximum age to 60 years, which excludes the elderly population. While some studies suggest that females have better taste sensitivity than males[23,24], this study found no significant differences between male and female subjects.

Genetic variations and ethnicity have been shown to influence taste perception. Studies conducted in the United States have demonstrated differences in taste intensity ratings among various ethnic groups, such as non-Hispanic black and non-Hispanic white adults.[25,26] Another study by *Yang et al.*[27] also showed differences in taste perception between Asians and Caucasians. Therefore, our results are more applicable for use with Thai patients.

CONCLUSION

The regional (spatial) taste test is a valuable tool for assessing gustatory function, complementing threshold tests and electrogustometry. The technique used in this study, adapted from the CCCRC spatial taste test, is also used in clinical practice at Siriraj's Smell & Taste

Clinic. This method effectively identifies taste function for specific taste stimuli in particular regions of the tongue and soft palate. Our findings revealed no significant difference in taste ability between the two sides of the mouth. The mean VAS score was highest for sweet as a tastant and for the posterior tongue as a tested area. Additionally, no significant differences were observed between sexes or among age groups when analyzed by tastant and area. This study also establishes normative values for Thai subjects, which can serve as a reference in future clinical practice. Further studies that include a broader patient age range, all smoking statuses, and patients with taste dysfunction would be valuable to enhance the generalizability and applicability of the data.

Data Availability Statement

The data that support the findings of this study are available upon request from the corresponding author, [K.A.]. The data are not publicly available due to containing information that could compromise the privacy of research participants.

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DECLARATION

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Conflict of Interest

The authors declare no conflict of interest.

Registration Number of Clinical Trial

TCTR20250211007

Author Contributions

Conceptualization and methodology, N.S. and P.A.; Investigation, N.S. and P.A.; Formal analysis, T.P., N.S. and K.A.; Visualization and writing – original draft, T.P., N.S., P.A. and K.A.; Writing – review and editing, T.P. and K.A.; Funding acquisition, P.A.; Supervision, P.A.; All authors have read and agreed to the final version of the manuscript.

Use of Artificial Intelligence

The manuscript was not produced using artificial intelligence.

Human Ethics Approval Declaration

This study was conducted according to the Declaration of Helsinki and was approved by the Siriraj Institutional Review Board (approval No. Si 676/2012). Informed consent was obtained from all individual participants involved in the study.

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