Progress in Nutrition 2025; Vol. 27, N. 2: 16899 DOI: 10.23751/pn.v27i2.16899

Original article

Assessment of detection threshold and preference for sweet taste across ethnicities in university students

Marina Abdul Manaf, Nur Asyirah Aziz
School of Health Sciences, Health Campus, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia

Abstract. *Background and aim:* Sweet taste sensitivity influences individual taste preferences, which may vary by gender and ethnicity. This study assessed the detection threshold and preference for sweet taste among undergraduate students of Malay, Chinese, and Indian ethnicities. *Methods:* Ninety students aged between 19 and 27 years were selected as panelists for this study. The three-alternative forced choice (3-AFC) method was employed to determine the detection threshold for sweet taste in sucrose solutions. A 9-point hedonic scale was used to determine the sensory preference for sweet taste in a tea beverage. *Results:* The findings indicate no significant difference ($p > 0.05$) in the detection threshold for sweet taste among the three ethnicities. The mean thresholds showed that Chinese students had the lowest detection threshold for sweet taste (8.25 mM), followed by Malay (9.78 mM) and Indian students (11.51 mM). In terms of sensory preference, Malay and Indian students preferred a higher degree of sweet taste (219 mM) than Chinese students (73 mM). *Conclusions*: In general, there was no correlation ($p > 0.05$) between detection threshold and preference for sweet taste among university students of different ethnic groups.

Key words: chinese, detection threshold, indians, malays, preference, sweet taste

Introduction

Sweet-tasting foods have historically been linked to dietary energy, with the consumption of energy-dense sweet foods believed to significantly contribute to the escalating global problem of overweight and obesity (1). The public health concern of obesity among the Malaysian population is gradually becoming more prevalent. Obesity is a primary risk factor for the onset of various diet-related chronic diseases, which raises significant concerns. The Malaysian National Health and Morbidity Survey (2023) indicates that 54.4% of Malaysian adults are classified as overweight or obese (2). One of the main causes of Malaysia's harmful eating habits is the ongoing increase in the availability of sugar and sweeteners. The widespread availability of ultra-processed foods provides evidence of this. In Malaysia, the energy contribution from added sugar in ultra-processed foods is 63% (3). Furthermore, the majority of Malaysian street foods (93%) have a medium to high sugar content (4). According to the Malaysian Adults Nutrition Survey (2024), the adults' mean intake of free sugar from foods and beverages are 20.9 and 21.9 g/day, respectively. Adolescents however, have a higher intake of free sugar, with 31.7 and 24.9 g/day for foods and beverages, respectively (5). Some research indicated a negative correlation between body mass index (BMI) and sweet taste sensitivity, while a substantial amount of evidence demonstrated no significant relationship between BMI and sweet taste function (6). Evidence indicates that dietary patterns emerge in early childhood and adolescence, persisting throughout maturity (7). Research demonstrates that exposure to sugar at an early age resulted in a preference for sweetened products and liking of foods with high sugar content (8).

University students are one of the populations that is normally associated with high sugar intake, specifically through sugar-sweetened beverages (SSBs) (9). Previous studies in Terengganu Malaysia reported that university students consumed two cups of SSBs on average per day (10). In Sarawak, Malaysia, 72.1% of university students consumed SSBs more than three times a week (11). A further study indicated that the average sugar consumption from SSBs of university students from Malaysia post- COVID-19 was 59.14 g/day, equivalent to 12 teaspoons of sugar (12). According to Norliza-Ahmad et al. (2019), the prevalence of at least one daily intake of SSBs among public universities in Malaysia is 89.3% (13). Due to concern regarding the high trend of sugar consumption among students, we undertook this study to examine the correlation between the detection threshold for sweetness and the sensory preference for sweet flavour among predominant ethnic groups of university students in Malaysia. We hypothesised that there is a significant difference in the detection threshold and preference for sweetness among different ethniticies.

Materials and Method

Participants

Ninety undergraduate students from the Health Campus of Universiti Sains Malaysia were recruited to serve as panelists in this study. According to Gacula and Rutenbeck (2006), the sample sizes of 40 and 100 are enough to generate stable averages for liking in a sensory evaluation testing method based on consumer tests (14). The number of participants was equally distributed between the races of Malays, Chinese, and Indians (30 per group), which represent the major ethnic groups in Malaysia. Participants were recruited based on convenience sampling through social media. We excluded those who had medical illnesses, had utilized tobacco products or exhibited signs of conditions that could affect gustatory perception. All participants gave their consent to participate on this study. This study procedures received approval from the Ethical Research Committee, Universiti Sains Malaysia (USM/JEPeM/16110431).

Detection threshold for sweet taste

The detection threshold for sweetness was established utilizing the three-alternative forced-choice (3-AFC) method in accordance with ASTM E679 (15). Panelists were provided with three samples, in which one sample consisted of a sucrose solution, while the remaining two samples consisted of water. Panelists had to indicate if they detect a taste experience distinct from that of water. A threshold concentration is the minimum concentration at which panelists can tell a difference between the sample and the water. Sucrose solutions prepared were 0.90, 1.81, 3.62, 7.25, 14.50, and 29.00 mM (16). Each concentration of sucrose solution included one set of samples, including one cup of sucrose solution and two cups of water (blank). A total of 10 ml of each concentration was presented in a small disposable cup, with three-digit numerals randomly assigned to each sample. The samples were arranged in ascending order of concentration. Prior to one hour of testing, panelists were instructed to refrain from consuming food, beverages, or brushing their teeth for one hour prior to the testing. Panelists could replicate the testing on the same concentration set if needed. Before proceeding to the subsequent higher concentration set, panellists were required to submit the response for each concentration. They had to rinse their mouths with tap water before testing the following round of samples.

Sweet taste preference

A sensory preference assessment was performed via a hedonic evaluation. A 9-point hedonic scale was used to assess the preference level of sugar concentration in the tea beverages. A score of 1 indicates extreme dislike, while a score of 9 indicates extreme liking. Panelists were instructed to assign a preference rating score for six concentrations of sugar in the tea beverages they sampled. The sensory preference score was derived by computing the average mean score for each concentration. A tea was made by steeping one tea bag in 200 ml of hot water for 5 minutes. The teabag was dipped five times before being taken out. The tea beverage was divided into six portions and various concentrations of sucrose were incorporated. The concentrations of sucrose used were 73, 146, 219, 292, 365, and 438 mM (16).

The tea solution was stirred until sucrose dissolved completely. The sensory evaluation session was conducted in a sensory laboratory equipped with individual booths to minimize distractions and biases. A 10 ml sample of tea beverage was presented in disposable cups, each labeled with a randomly assigned three-digit number and arranged in a random position. Samples were served at approximately 60 – 70°C. Samples for tasting were performed consecutively from left to right. Panelists were instructed to assess their sweetness preference for each of the samples. They were required to rinse their mouths with tap water in between samples.

Statistical analysis

The detection threshold for each panelist was indicated as a sequence, with (0) denoting an incorrect selection and (+) indicating a correct selection, organized in ascending concentration order. The Best-Estimation Threshold (BET) was employed to determine the detection threshold. The individual BET is estimated using the geo-mean of concentration, where a (0) represents the last miss and a (+) indicates the next higher concentration. The following equation was used to calculate the geo-mean:

$$\text{Geo mean} = \sqrt{X_{(-)} \cdot X_{(+)}}$$

The group threshold was calculated from the geometric mean of the BET values.

The Statistical Package of Social Science (SPSS) Version 27 was employed to analyze the data. A *p*-value of less than 0.05 was used to designate the statistically significant. The data was normally distributed and was determined using the skewness and kurtosis values (17). We examined the detection threshold and sensory preference for sweetness among the three ethnic groups utilizing the one-way analysis of variance (ANOVA) test. A Pearson's correlation test was employed to investigate the association between sensory detection threshold and preference for sweetness.

Results

Table 1 presents the demographic profiles of the participants. Among the 90 students in this study, 45.5% were males and 54.4% were females. The subjects ranged from 19 to 27 years old. For Malay, Chinese, and Indian students, the number of male students was 14, 14, and 13, respectively. The number of female students was 16, 16, and 17 for Malay, Chinese, and Indian students, respectively. The participants of the study consisted of 43, 24, and 23 from the School of Health Sciences, School of Medical Sciences, and School of Dental Sciences, respectively. The detection threshold for sweet taste

Table 1. Demographic characteristics of the participants

	Frequency, n	Percentage, %
Age Groups:		
19 - 22 years old	55	61.1
23 - 27 years old	35	38.9
Schools:		
Health Sciences	43	47.8
Medical Sciences	24	26.7
Dental Sciences	23	25.5
Ethnicity:		
Malay		
Male	14	46.7
Female	16	53.3
Chinese		
Male	14	46.7
Female	16	53.3
Indian		
Male	13	43.3
Female	17	56.7

Table 2. Detection threshold for sweet taste among Malay, Chinese and Indian students

Ethnicity	Detection threshold for sweet taste (mM)
Malay	9.78
Chinese	8.25
Indian	11.51

Mean values were determined using the one-way analysis of variance (ANOVA) test.
There was no significant difference between the ethnicities ($p > 0.05$).

Table 3. Sensory preference for various levels of sweet taste and its correlations with sweet detection threshold

Concentration of sucrose (mM)	Malay	Chinese	Indian	Correlations of sweet detection threshold and preference	
				p-value	*r*
73	4.53[a]	5.27[ab]	3.73[b]	0.956	0.006
146	5.77[ab]	5.20[b]	6.37[a]	0.052	0.206
219	6.37[a]	4.67[b]	6.50[a]	0.514	0.070
292	5.73[a]	3.90[b]	6.20[a]	0.627	0.052
365	4.97[a]	3.80[a]	4.43[a]	0.956	0.006
438	4.23[a]	3.33[a]	4.10[a]	0.676	0.045

Means with different letters indicate a significant difference at $p < 0.05$
Significant difference was determined using a one-way analysis of variance (ANOVA) test
Correlation analysis was determined using a Pearson's correlation test.

is illustrated in Table 2. Chinese (8.25 mM) had the lowest, while Indian students (11.51 mM) had the highest detection threshold among ethnics. Nevertheless, there was no statistically significant difference ($p > 0.05$) in the detection threshold among all ethnicities. Table 3 shows the sensory preference for sweet taste among participants. There was a significant difference ($p < 0.05$) for all sucrose concentrations, except for the two highest concentrations (365 and 438 mM). Chinese students had the lowest preference for all the sucrose concentrations, except for the lowest concentration (73 mM), in which they scored the highest sucrose preference, compared to Malay and Indian students. Between 146 and 292 mM, Indian students expressed the highest preference for sweet taste. Malay students had the highest preference for the two highest sucrose concentrations (365 and 438 mM), but there was no significant difference ($p > 0.05$) in comparison with other ethnic groups. Both the Malay (6.37) and Indian students (6.50) recorded the 219 mM concentration (third lowest) as the highest preference score. The Chinese students primarily favoured the sucrose concentration of 73 mM, which was the lowest concentration. For all sucrose concentrations and across all ethnic groups, the correlation analysis demonstrated that there was no significant difference ($p > 0.05$) between the sweet taste detection threshold and the preference for sweet taste.

Discussion

Few studies have compared the sensitivity of sweet taste and preference across ethnic groups. However, neither a direct nor an inverse relationship appears to consistently link the detection threshold and preference. Previous study demonstrated that Malays perceive sweet stimuli at a lower intensity than other ethnicities, yet they observed no significant difference in the influence of ethnicity on the pleasantness of sweetness (18). Similar to the study, our finding did not establish any relationship between detection threshold in sweet taste and preference for sweet taste among ethnicities. Uswatun (2014) also examined the impact of multiculturalism on the sweet detection threshold and found no significant difference between multiculturalism and sensory preference for sweetness (16). In this study, we found that Chinese students had the lowest detection threshold for sweet taste, an indication that they were most sensitive to it. The Indian students, on the other hand, had the highest detection threshold (the least sensitive to sweet taste) among all ethnic groups. This result supported the study by Shu-Fen et al. (2018), whereby Indians in Singapore had a higher recognition threshold for sweet taste than the Chinese (19). Furthermore, the present study's results on sweet taste preference indicate that Chinese students preferred tea beverages with the lowest concentration of sucrose. This result aligns with the findings of the nationwide health survey in Malaysia

(2019), which revealed that Chinese individuals consume the least amount of added sugar on a daily basis, while Indians have the highest consumption (20). Abdullah et al. (2016) reported a notable disparity in dietary patterns among different ethnic groups, with Chinese adolescents exhibiting a greater consumption of health-oriented food patterns compared to Malay participants (21). This finding is consistent with the result of the present study. The healthy lifestyle factor among Chinese students likely encourages them to consume less sugar, which in turn leads to a decreased preference for sweet taste. Previously, a study identified a significant positive association between the preferred concentration of sucrose solution and the frequency of sweet food and beverage consumption (22). Genetic differences may contribute to a difference in food preferences. Chemical compositions contained in food trigger certain taste receptors, and the receptors can be influenced by genetic variations, which result in different tastes and preferences among individuals (23). Receptors for recognition of sweet and umami tasting ligand are encoded by genes in the *TAS1R* gene family (24). Recent finding identifies two single nucleotide polymorphisms (SNPs) known as rs80115239 and rs12878143, as having the strongest and weakest association with sweet taste preferences (25). Ooi et al. (2010) performed a study to determine if genetic factors related to taste affected food choices among Malaysians (26). They found that ethnicity (Malay, Chinese, or Indian) was associated with the bitter receptor gene P49A TAS2R38. However, the gene could not serve as a predictor of aversion to sweet or fat foods in Malaysian subjects, suggesting that other factors might be influencing Malaysian food selection. Besides genetic, cultural practices also play a role in the determination of sweetness preferences. Cultural variations in the familiarity with certain food products are common and the level of familiarity can influence the food preferences (27). Despite the fact that globalization and urbanization have altered food preferences, traditional dietary practices have demonstrated resilience (28). Culturally accepted dietary norms gradually nurture diet and sugar eating habits, particularly sweet preference levels, over time. A study by Toh et al. (2016) on infant feeding found that the percentage of Chinese infants fed juices and sweetened drinks was significantly lower than for Malays and Indians (29). As a result, the introduction of sweet tastes to Malays and Indians during infancy was more prevalent than it was for Chinese infants. Thus, the high preference for sweetness in Indian and Malay students and the lower sweetness preference by Chinese students in the present study may have resulted from their sugar consumption habit, which started at a younger age. These findings are corroborated by a previous study which found that the Malay ethnic group consumed the most added sugar (54.0 g/day), followed by Indians (44.4 g/day) and Chinese (29.8 g/day) (30). Other studies have also proven that people with more exposure and who consume sweet food regularly tend to have a strong inclination towards sweetness (20,31). Our findings also supported the results of related studies conducted in other countries. Browser et al. (2018) reported that non-Hispanic Black adults had a higher intensity of sweet taste perception than non-Hispanic white adults (32). The difference in ethnicities also results in differences in taste responsiveness, which has been demonstrated by Williams et al., (2016), whereby a comparison in taste responsiveness shows that Hispanics and African Americans rated taste sensations higher than non-Hispanic Whites (33). Another study comparing Japanese and Sri Lankan students found that subjective taste, including sweetness, differs according to nationalities (34). Thus, understanding that different ethnicities have different taste perceptions and preferences can help in the implementation of health policy because it will contribute to different dietary risks such as diabetes and obesity. Therefore, future intervention studies must consider the unique sensory capabilities of each ethnicity when attempting to modify their diet.

Conclusion

The current study indicates a variance in detection thresholds and preferences for sweet taste across Malay, Chinese, and Indian university students. Chinese students were most sensitive to sweet taste and preferred the lowest concentration of sucrose compared to Malay and Indian students. Nonetheless, no correlation was observed between detection threshold and

preference for sweet taste among the ethnic groups. This highlights the necessity for culturally customized dietary guidelines and interventions that take into account the distinct preferences and practices of various ethnic groups. The lack of correlation between sweet taste detection thresholds and preference suggests that elements beyond biological sensitivity, such as cultural norms, upbringing and dietary habits, plays a significant role in shaping sweet preferences. This highlights the importance of addressing behavioral and environmental factors in sugar reduction strategies. It is suggested that intervention programs are implemented that are targeted at the community level, such as workshops that could help individuals make informed choices about their sugar consumption.

Acknowledgements: Authors are thankful to those who participated in this study. The authors are also grateful to School of Health Sciences, Universiti Sains Malaysia for providing facilities to conduct the study.

Authors' contribution: MAM: conception and design of study, manuscript writing; NAA: data collection, analysis and interpretation of data.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

References

1. Prinz P. Sweetness preference and its impact on energy intake and body weight – a review of evidence. Front Nutr. 2023;10:1289028. doi: 10.3389/fnut.2023.1289028
2. Institute for Public Health (IPH). National health and morbidity survey 2023: non-communicable diseases and healthcare demand - key findings. 2023. p. 8.
3. Asma' A, Lokman NAH, Hayati MY, Zainuddin AA. Ultra-processed food classification, their contribution to sodium and added sugar availability, and its relationship with nutritional status among adults in Terengganu, Malaysia. IIUM Med J Malays. 2023;18(3):49-58.
4. Arifen ZNZ, Shahar S, Trieu K, Majid HA, Noh MFM, Haron H. Individual and total sugar contents of street foods in Malaysia – should we be concerned? Food Chem. 2024;450:139288. doi: 10.1016/j.foodchem.2024.139288
5. Institute for Public Health (IPH). National health and morbidity survey 2024 (NHMS): fact sheet. 2025.
6. Low JYQ, Lacy KE, McBride R, Keast RSJ. The association between sweet taste function, anthropometry, and dietary intake in adults. Nutrients. 2016;8(4):241. doi: 10.3390/nu8040241
7. Appannah G, Murray K, Trapp G, Dymock M, Oddy WH, Ambrosini GL. Dietary pattern trajectories across adolescence and early adulthood and their associations with childhood and parental factors. Am J Clin Nutr. 2021;113:36-46. doi: 10.1093/ajcn/nqaa281
8. Drewnowski A, Menella JA, Johnson SL, Bellisle F. Sweetness and food preference. J Nutr. 2012;142(6):1142S-1148S. doi: 10.3945/jn.111.149575
9. Prada M, Godinho CA, Garrido MV, Rodrigues DL, Coelho I, Lopes D. A qualitative study about college students' attitudes, knowledge and perceptions regarding sugar intake. Appetite. 2021;159:105059. doi: 10.1016/j.appet.2020.105059
10. Bakar AAA, Hussin N, Jalil AMM, Mohamad M. Association between sugar-sweetened beverage consumption and body mass index among university students in Kuala Nerus, Terengganu, Malaysia. Malays J Public Health Med. 2020;20(2):19-26.
11. Cheah WL, Law LS, Myat SB, et al. Consumption of sugar-sweetened beverages: a cross-sectional study among university students in Sarawak. Turk J Public Health. 2023;21(2):177-87.
12. Cheng SH, Lau MY. Increased consumption of sugar-sweetened beverages among Malaysian university students during the Covid-19. Malays J Soc Sci Humanit. 2022;2:e001599. doi: 10.47405/mjssh.v7i7.1599
13. Norliza-Ahmad, Muhammad Afiq-Md Zuki, Nur Azilah-Azahar, Boon Han-Khor, Halimatus Sakdiah-Minhat. Prevalence and factors associated with sugar-sweetened beverage intake among undergraduate students in a public university in Malaysia. Pak J Nutr. 2019;18(4):354-63. doi: 10.3923/pjn.2019.354.363
14. Gacula M, Rutenbeck S. Sample size in consumer test and descriptive analysis. J Sens Stud. 2006;21(2):129-45. doi: 10.1111/j.1745-459X.2006.00055.x
15. ASTM E679. Standard practice for determination of odor and taste thresholds by a force-choice ascending concentration series method of limits. ASTM International; 2011. West Conshohocken, PA.
16. Uswatun H. Ambang sensori rasa dasar dan preferensi dalam matriks pangan dengan pendekatan multikultural di Indonesia. MSc Thesis. Bogor Agricultural University; 2014.
17. Kim HY. Statistical notes for clinical researchers: assessing normal distribution using skewness and kurtosis. Restor Dent Endod. 2013;38(1):52-4. doi: 10.5395/rde.2013.38.1.52
18. Thai PK, Tan EC, Tan WL, Tey TH, Kaur S, Say YH. Sweetness intensity perception and pleasantness ratings of sucrose, aspartame solutions and cola among multi-ethnic Malaysian subjects. Food Qual Prefer. 2011;22(3):281-9. doi: 10.1016/j.foodqual.2010.11.004

19. Shu-Fen CL, Forde CG, Tey SL, Henry CJ. Taste sensitivities and diet of Chinese and Indians in Singapore. Asia Pac J Clin Nutr. 2018;27(3):681-5. doi: 10.6133/apjcn.062017.04
20. Cheah YK, Sharif SP, Adzis AA. Sociodemographic, lifestyle and insurance factors associated with household expenditure on sugary foods: a pooled cross-sectional analysis. Hum Nutr Metab. 2023;32:200187. doi: 10.1016/j.hnm.2023.200187
21. Abdullah NF, Teo PS, Foo LH. Ethnic differences in the food intake patterns and its association factors of adolescents in Malaysia. Nutrients. 2016;8(9):551. doi: 10.3390/nu8090551
22. Holt S, Cobiac L, Beaumont-Smith N, Easton K, Best DJ. Dietary habits and the perception and liking of sweetness among Australian and Malaysian students: a cross-cultural study. Food Qual Prefer. 2000;11(4):299-312. doi: 10.1016/S0950-3293(99)00076-2
23. Hejazi J, Amiri R, Nozarian S, Tavasolian R, Rahimlou M. Genetic determinants of food preferences: a systematic review of observational studies. BMC Nutr. 2024;10:24. doi: 10.1186/s40795-024-00828-y
24. Holgerson PL, Hasslöf P, Esberg A, et al. Genetic preference for sweet taste in mothers associates with mother-child preference and intake. Nutrients. 2023;15:2565. doi: 10.3390/nu15112565
25. Bae JH, Kang H. Longitudinal analysis of sweet taste preference through genetic and phenotypic data integration. Foods. 2024;13:3370. doi: 10.3390/foods13213370
26. Ooi SX, Lee PL, Law HY, Say YH. Bitter receptor gene (TAS2R38) P49A genotypes and their association with aversion to vegetables and sweet/fat foods in Malaysian subjects. Asia Pac J Clin Nutr. 2010;19(4):491-8.
27. Jeong S, Lee J. Effects of cultural background on consumer perception and acceptability of foods and drinks: a review of latest cross-cultural studies. Curr Opin Food Sci. 2021;42:248-56. doi: 10.1016/j.cofc.2021.07.004
28. Lindsey M. Cross-cultural differences in food preferences and consumption patterns. Int J Food Sci. 2024;5(1):30-42.
29. Toh JY, Yip G, Han WM, et al. Infant feeding practices in multi-ethnic Asian cohort: the Gusto study. Nutrients. 2016;8(5):293. doi: 10.3390/nu8050293
30. Nik Shanita S, Norimah AK, Abu Hanifah S. Development and validation of a food frequency questionnaire (FFQ) for assessing sugar consumption among adults in Klang Valley, Malaysia. Malays J Nutr. 2012;18(3):283-93.
31. Mela DJ, Risso D. Does sweetness exposure drive 'sweet tooth'? Br J Nutr. 2024;131:1934-44. doi: 10.1017/S0007114524000485
32. Browser S, Farnsworth N, Russell K, et al. Sweet taste perception is greater in non-Hispanic black than in non-Hispanic white adults. Nutrients. 2019;59:103-7. doi: 10.1016/j.nut.2018.08.003
33. Williams JA, Bartoshuk LM, Fillingim RB, Dotson CD. Exploring ethnic difference in taste perception. Chem Senses. 2016;41:449-56. doi: 10.1093/chemse/bjw021
34. Koyama Y, Premarathne SD, Oppilamany T, et al. Differences in subjective taste between Japanese and Sri Lankan students depending on food composition, nationality, and serum zinc. Clin Nutr Exp. 2019;23:60-8. doi: 10.1016/j.yclnex.2018.10.006

Correspondence:
Received: 19 February 2025
Accepted: 1 June 2025
Marina Abdul Manaf
School of Health Sciences, Health Campus, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan, Malaysia
E-mail: mareena@usm.my
ORCID: 0000-0002-8859-5533