Malaysian Applied Biology (2022) 51(6): 27-34
https://doi.org/10.55230/mabjournal.v51i6.2381

Research Article

Sweet Taste Preference Status and its Association with Preference for the Four Basic Taste Modalities of Various Food

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ABSTRACT

Sweetness preference is a complex sensation involving multidisciplinary fields and it has been studied extensively. However, there is still limited information on how the status of the sweet preference of individuals influences their preference for other taste modalities. Thus, this study was conducted to observe the difference in the preference for various types of foods based on the four taste modalities, with sweet taste preference (STP) status. This cross-sectional study involved 156 university students in Kelantan, Malaysia. The preference test of tea drink sweetness was determined using the hedonic test. Subjects were grouped into low, medium, and high STP according to their STP level. The preference for the taste modalities of different food groups was determined by using a questionnaire. The results indicated that the majority of subjects were in the medium STP group. Foods categorized under the sweet taste group were mostly correlated with the STP status, followed by salty and sour foods. There was no correlation (p>0.05) between STP status and bitter foods. This result agrees with the principal component analysis (PCA). Two factors were extracted from PCA, in which the first factor explained 56.41% and the second factor explained 20.45% of the variance. Sweetness is related to foods that are categorized under salty and sour tastes, but not related to bitter tastes. This study shows that sweetness preference status is associated with preference for two other basic tastes. The high STP subject not only prefers sweet foods but also favors foods from salty and sour groups.

Key words: Bitter, preference, salty, sour, sweet

Article History
Accepted: 29 October 2022
First version online: 4 December 2022

Cite This Article:
Abdul Manaf, M., Mohamad Zazali, N.N. & Abdul Wahid, S.A.I. 2022. Sweet Taste preference status and its association with preference for the four basic taste modalities of various food. Malaysian Applied Biology, 51(6): 27-34. https://doi.org/10.55230/mabjournal.v51i6.2381

INTRODUCTION

Preference for sugar has been studied by many researchers due to sugar being an important food to affect the health of the public. Among all tastes, sweet taste can be considered as having the most pleasant appeal and is well-liked by many people (Jayasinghe *et al*., 2017). Humans are naturally born with a preference for sweetness (Drewnowski *et al*., 2012). Unfortunately, a liking for sweet tastes might lead to increased consumption of sugar. Excess consumption of sugar has been linked to the increased incidence of health diseases such as dental caries, obesity, and obesity-related disease (Skillings *et al*., 2014; Divert *et al*., 2017).

The variance of sweet taste preference status (STP) plays a vital role in dietary intake and preferences for different taste food groups (Asao *et al*., 2015). Individuals with a high STP may require a high amount of sweet taste to be satisfied with the sweet taste perception they are experiencing compared to an individual with lower or medium STP (Low *et al*., 2014). There is also an increased possibility that individuals with high STP prefer food with a high amount of sugar and reject others. Thus, this might be a factor in fussy eating, which results in an unhealthy eating pattern (Cheung *et al*., 2022).

As food preference is associated with dietary intake, human preference for sweet taste has been the subject of studies by many researchers (Ashi *et al*., 2017; Iatridi *et al*., 2019). It is generally expected that a high preference

for sweet taste would lead to a high preference for food and drink with a high sweetness level. However, little is known about the influence of STP on the preference for foods group dominated by different tastes such as sweet, sour, and bitter.

Each of the taste modalities has been associated with specific functions essential for human health and well–being (Tan & Tucker, 2019). For example, the quality of a sweet taste provides a guide in identifying the type of calorie-rich food or the source of carbohydrates. Acid balanced is maintained and controlled by a salty and sour detection in the taste bud. Bitter detection is crucial as it warns us of the poison that may contain in foods as poisonous compounds are mainly produced by plants for defense and are bitter.

The preference for sweetness may contribute to excessive consumption of sugary foods and thus increase the prevalence of obesity (Wilk *et al*., 2022), while the preference for saltiness may contribute to a high intake of salt and thus increase the likeliness of hypertension (Li *et al*., 2022). However, the preference for taste modalities such as sweetness and saltiness was mostly done separately. Thus, how each taste modality influences the preference for other taste modalities remains unknown. It is worth examining any possible relationship among preferences for all taste modalities as it may assist in the identification of an optimal strategy to tackle issues such as excessive intake of sugar and salt. Understanding the role of each taste preference in STP status will provide insight into interaction among taste modalities. Thus, this study aimed to evaluate the association between STP status, determined by the serial concentration of sucrose in tea beverages, with the taste preference of different taste modalities namely sweet, salty, sour, and bitter, using a self-reported questionnaire.

MATERIALS AND METHODS

Subjects

This is a cross-sectional study that involved 156 undergraduate students (aged between 19 to 25 years old) in Kelantan state, Malaysia, chosen by a convenience sampling technique. The university students were chosen as they represent the large youth generation in Malaysia. The inclusion criteria were undergraduate students who were free from any disease or condition that can alter taste sensation. Subjects were excluded if they were a smoker or taking long-term medication for chronic disease. The research procedure was approved by the Human Ethical Research Committee, Universiti Sains Malaysia (USM/JEPeM/18070313).

Sweet taste preference status

The STP status was determined by measuring the preference for sweetness among subjects in tea beverages, according to the method by Uswatun (2014). Tea beverage was prepared by brewing one bag of tea (Lipton) with boiling water of 300 mL and allowed to stand for 5 min. Before the tea bag was removed, it was further dipped another 5 consecutive times. The tea beverage was divided into six portions and added with different concentrations of sucrose were. The concentrations of sucrose used were 2.5, 5, 7.5, 10, 12.5, and 15% (w/v). To reflect the preference for sweet taste in real-life situations, tea beverage was used in this study rather than plain water.

Sensory preference was conducted by using a hedonic test. A 9-point hedonic scale was used to determine the preference level for sweetness in tea drinks. A scale of 1 represents dislike extremely and 9 represents like extremely. A sample of 10 mL of tea was served in a disposable cup, coded randomly with 3-digit numbers. Subjects were instructed to rinse their mouth between samples. After tasting each sample, subjects filled up their preferences based on the sweetness level.

The STP score was determined by multiplying the concentration of the sucrose level with the hedonic score given by the subjects. The total STP score for each subject was determined by adding all the STP scores from all six samples of tea beverages. The STP scores were transformed into categorical data to classify subjects into low, medium, and high STP. Subjects were categorized into low STP if their STP scores fall in the lower percentile (25^{th} percentile). The subjects were categorized into the high STP group if their STP scores fall in the higher percentile (75^{th} percentile). The remaining subjects were categorized as medium STP.

Food preference

Food preference based on different taste modalities, namely sweet, salty, sour, and bitter was determined by using a food preference questionnaire, according to Syathirah Hanim *et al*., (2020). The foods consisted of commonly consumed foods by Malaysians. Subjects were required to indicate their preference towards the foods on a 7-point hedonic scale, from ‘dislike extremely’ to ‘like extremely’.

Statistical analysis

The Nutritionist Pro™ Diet Analysis Software using the Malaysian food database was used to analyze the nutrient intakes of the participants. All data collected were entered and analyzed using IBM Statistical Package of Social Science (SPSS) version 24.0. One-way ANOVA test was used to carry out significant difference mean for STP scores among low, medium, and high STP. STP score rating was correlated with food preference

by using Spearman's rank correlation. The value of $p<0.05$ was considered statistically significant. Principal component analysis (PCA) was used to study the interaction among the various tastes using XLSTAT software (2019).

RESULTS

Sweet taste preference status

The demographic characteristics of the participants in this study are shown in Table 1. This study included a total of 156 undergraduate students. The majority of the subjects were females, which constitutes about 79.5% and the remainder of 20.5% were male students. The Malays (78.8%) constitute the highest number of participants, followed by Chinese (10.9%), other ethnic minorities (5.8%), and Indians (4.5%). Most subjects were in the range of 19 to 22 years old (61.5%). Subjects with medium STP (59%) constituted the largest percentage, followed by low STP (22.4%) and high STP (18.6%) subjects. The percentage of high STP for males (31.2%) was more than double the percentage for high STP females (15.3%).

Food preference

The food preference based on various taste modalities among low, medium, and high STP is shown in Table 2. Under the sweet taste modality, candy, chocolate cake, chocolate syrup, honey, and muffin were some of the foods which had significant differences ($p<0.05$). There was a significant difference between high STP and low STP in all of the foods studied, with high STP subjects having a significantly higher preference for all of those foods, compared to low STP subjects.

For salty foods, high STP subjects had significantly ($p<0.05$) higher preference for the chicken nugget, dried anchovies, and fried noodles compared to low and medium STP subjects. In addition, high STP subjects significantly preferred ($p<0.05$) sour food groups such as blueberry, cranberry, and red currant juice, compared to low and medium STP subjects. Unlike other food taste groups, there was no significant difference ($p>0.05$) among subjects in the bitter food group, except for cabbage, in which low STP subject least preferred ($p<0.05$) the vegetable.

Based on the correlation results, there was a significant correlation between STP status and preference for most of the foods under the sweet food category, namely candy ($r=0.22$, $p<0.01$), chocolate syrup ($r=0.29$, $p<0.01$), honey ($r=0.27$, $p<0.01$), jelly ($r=0.17$, $p<0.05$), muffin ($r=0.19$, $p<0.05$), popcorn caramel ($r=0.23$, $p<0.01$) and popsicles ($r=0.21$, $p<0.01$). Under the salty foods category, cheddar cheese ($r=0.20$, $p<0.05$), chicken nuggets ($r=0.30$, $p<0.01$), dried anchovies ($r=0.22$, $p<0.01$), fried noodles ($r=0.20$, $p<0.05$), fried rice ($r=0.25$, $p<0.01$) and potato chips ($r=0.16$, $p<0.05$) were found to be positively correlated with the STP status. The list of foods under the sour taste category that was correlated with STP status was blueberry ($r=0.20$, $p<0.05$), cranberry ($r=0.32$, $p<0.01$), grapefruit ($r=0.17$, $p<0.05$), red currant juice ($r=0.19$, $p<0.05$) and sour milk ($r=0.19$, $p<0.05$). No correlation ($p>0.05$) was found between STP status and bitter foods.

Figure 1 shows the loading plot of the correlation between the first two components of PCA and food groups based on taste. Two factors were extracted, with the first factor explaining 56.41% of the variance and 20.45% explaining the second factor. Sweetness is related to salty and sour tastes, based on the acute angle. However, the sour taste is not as well represented as the other two tastes, given its slightly shorter vector length. The bitter taste is not related to other tastes.

Table 1. General characteristics of participants

	Low STP (n=35)	Medium STP (n=92)	High STP (n=29)	Total (n=156)
Gender				
Female	31 (25.0)	74 (59.7)	19 (15.3)	124
Male	4 (12.5)	18 (56.3)	10 (31.2)	32
Race				
Malay	27 (21.9)	72 (58.5)	24 (19.5)	123
Chinese	4 (23.5)	12 (70.6)	1 (5.9)	17
Indians	0 (0.0)	4 (57.1)	3 (42.9)	7
Others	4 (44.4)	4 (44.4)	1 (11.1)	9
Age				
19 - 22	20 (20.8)	56 (58.3)	20 (20.8)	96
23 - 26	15 (25.0)	36 (60.0)	9 (15.0)	60

Numbers in parentheses indicate the percentage

Table 2. Sweet taste preference (STP) score and correlations of STP status with food preference of various tastes

Food Groups	Mean (SD) Sweet Taste Preference (STP)				Correlations of STP status and food preference (*r*)
	Low STP (*n*=35)	Medium STP (*n*=92)	High STP (*n*=29)	*p*-value	
Sweet Food					
Chocolate Bar	5.46 ± 1.29	5.40 ± 1.53	6.03 ± 1.18	0.108	0.115
Baby Corn	4.54 ± 1.74	4.96 ± 1.47	4.41 ± 1.66	0.176	0.002
Candy	4.40 ± 1.70[b]	4.90 ± 1.35[ab]	5.31 ± 1.34[a]	**0.041**	0.222**
Chocolate cake	5.63 ± 1.40[b]	5.59 ± 1.56[b]	6.34 ± 1.01[a]	**0.044**	0.139
Chocolate spread	5.26 ± 1.42	5.22 ± 1.64	5.93 ± 1.49	0.095	0.135
Chocolate syrup	4.09 ± 1.79[b]	4.99 ± 1.53[a]	5.62 ± 1.52[a]	**0.001**	0.294**
Cookies	5.66 ± 1.21	5.64 ± 1.35	5.86 ± 1.13	0.713	0.061
Doughnut	5.34 ± 1.35	5.24 ± 1.43	5.66 ± 1.14	0.359	0.118
Honey	4.43 ± 1.54[b]	5.03 ± 1.46[ab]	5.55 ± 1.48[a]	**0.011**	0.270**
Ice-cream	5.80 ± 1.13	5.99 ± 1.18	5.76 ± 1.50	0.582	0.064
Jam	4.34 ± 1.45	4.67 ± 1.40	4.83 ± 1.58	0.370	0.117
Jelly	4.54 ± 1.40	4.97 ± 1.26	5.07 ± 1.53	0.211	0.169*
Marshmallow	4.20 ± 1.80	4.42 ± 1.56	4.55 ± 1.88	0.687	0.100
Milk Chocolate	5.20 ± 1.91	5.37 ± 1.61	6.00 ± 1.49	0.126	0.150
Muffin	5.06 ± 1.45[b]	5.36 ± 1.46[ab]	5.97 ± 1.27[a]	**0.038**	0.189*
Popcorn Caramel	4.89 ± 1.53	5.24 ± 1.52	5.62 ± 1.05	0.131	0.232**
Popsicles	4.26 ± 1.60	4.93 ± 1.49	4.93 ± 1.77	0.083	0.207**
Salty Food					
Cheddar cheese	5.40 ± 1.33	5.34 ± 1.61	6.00± 1.20	0.107	0.195*
Chicken nugget	5.43 ± 1.27[b]	5.79 ± 1.40[b]	6.52 ± 0.51[a]	**0.003**	0.298**
Corn snacks	4.49 ± 1.52	4.66 ± 1.33	5.03 ± 1.27	0.266	0.088
Dried anchovies	4.00 ± 1.57[b]	4.35 ± 1.50[b]	5.03 ± 1.48[a]	**0.024**	0.216**
Dried cuttlefish	3.49 ± 1.84	3.82 ± 1.74	3.86 ± 1.68	0.594	0.034
Dried prawns	3.57 ± 1.72	3.53 ± 1.66	3.93 ± 1.56	0.521	0.094
Dried salted fish	3.54 ± 1.82	3.92 ± 1.84	3.90 ± 1.74	0.561	0.080
Fried noodles	5.00 ± 1.53[b]	4.95 ± 1.63[b]	5.76 ± 1.30[a]	**0.043**	0.196*
Fried rice	5.46 ± 1.07	5.48 ± 1.31	6.00 ± 1.40	0.134	0.245**
Noodles with soup	5.66 ± 1.59	5.70 ± 1.20	6.10 ± 1.32	0.304	0.049
Noodles with soy sauce	4.97 ± 1.64	4.90 ± 1.36	5.48 ± 1.41	0.162	0.127
Potato chips	5.11 ± 1.45	5.43 ± 1.41	5.86 ± 0.83	0.085	0.164*
Prawn crackers	4.51 ± 1.62	4.55 ± 1.56	5.24 ± 1.33	0.089	0.152
Salted squids	3.23 ± 1.72	3.57 ± 1.91	3.90 ± 1.93	0.365	0.089
Soup	5.60 ± 1.42	5.91 ± 1.10	6.00 ± 1.41	0.354	0.064
Sour Food					
Blueberry	4.66 ± 1.45[b]	4.78 ± 1.34[b]	5.48 ± 1.09[a]	**0.026**	0.204*
Cranberry	4.06 ± 1.45[b]	4.38 ± 1.34[b]	5.34 ± 1.08[a]	**0.000**	0.324**
Grapefruit	5.29 ± 1.60	5.76 ± 1.36	6.10 ± 1.24	0.063	0.170*
Lemon	4.77 ± 1.66	4.57 ± 1.45	5.07 ± 1.41	0.275	0.006
Orange	5.86 ± 1.35	5.65 ± 1.31	5.86 ± 1.13	0.615	-0.004
Red currant juice	4.29 ± 1.45[b]	4.45 ± 1.43[b]	5.28 ± 1.22[a]	**0.010**	0.187*
Sour milk	2.91 ± 1.87	3.37 ± 1.87	4.00 ± 1.67	0.072	0.190*
Strawberry	5.23 ± 1.52	5.23 ± 1.59	5.86 ± 1.53	0.147	0.150
Yogurt	5.80 ± 1.57	5.80 ± 1.36	6.07 ± 1.00	0.635	-0.004
Bitter Food					
Bitter gourd	2.66 ± 1.98	3.13 ± 1.89	2.76 ± 1.64	0.367	0.025
Broccoli	5.09 ± 1.93	5.52 ± 1.43	4.79 ± 1.88	0.084	-0.069
Cabbage	4.97 ± 1.72[b]	5.68 ± 1.30[ab]	5.55 ± 1.21[a]	**0.037**	0.034
Cauliflower	5.20 ± 1.81	5.71 ± 1.31	5.66 ± 1.26	0.199	0.079
Chinese kale	4.54 ± 2.16	5.16 ± 1.61	5.28 ± 1.73	0.158	0.069

...continued

Table 1 continued...

Coffee	4.71 ± 1.84	4.71 ± 1.90	5.03 ± 1.57	0.689	-0.001
Cucumber	4.60 ± 1.82	5.12 ± 1.51	5.41 ± 1.21	0.094	0.091
Dark chocolate	4.83 ± 1.82	4.97 ± 1.78	5.21 ± 1.40	0.680	-0.062
Eggplant	3.91 ± 2.05	4.18 ± 1.79	3.83 ± 1.89	0.585	-0.016
French bean	4.51 ± 1.82	4.73 ± 1.48	4.72 ± 1.71	0.788	0.030
Lady's fingers	4.71 ± 2.26	4.93 ± 1.79	4.93 ± 2.10	0.844	0.004
Plain tea	3.83 ± 1.81	4.39 ± 1.78	4.38 ± 1.66	0.234	0.085

Values presented are means ± SD

p-value in bold indicates a significant difference ($p<0.05$) with different letters in a row showing significant differences.

r-value with (*) indicates significant difference at $p<0.05$, *r* value with (**) indicates significant difference at $P<0.01$

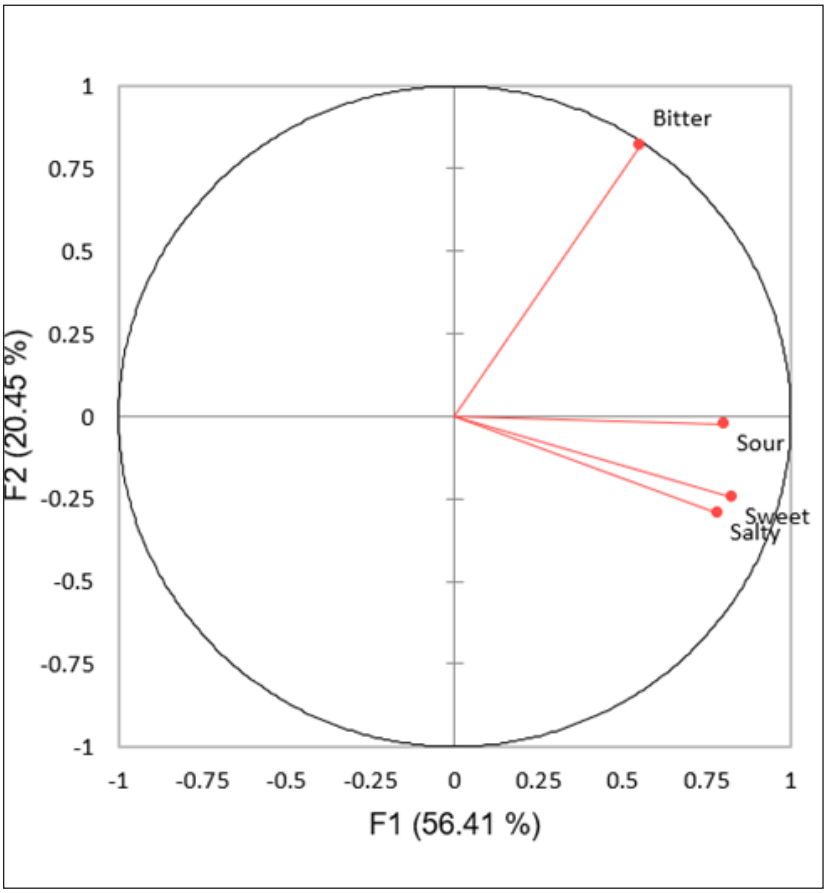

Fig. 1. Principal component analysis of various taste preferences.

DISCUSSION

The present study shows that the majority of subjects in this study were in the medium STP category. Only a small percentage of the subjects were in the high STP. Because the subjects in this study were health campus students, the majority of whom were from the school of health sciences, it is expected that they have a high level of health consciousness and are more concerned about a healthy lifestyle than the general population. This, in turn, may influence and shape their food preferences for the better. Although the majority of both male and female subjects fall under the medium STP, the male subjects in this study, however, had a higher percentage in the high STP group as compared to female subjects. This finding supported the study by Yang *et al*. (2020) who reported that males were more likely to be high sweet likers.

In the present study, it was found that the sweet food groups had the most food items being significantly different ($p<0.05$) among subjects, compared to food from the other modalities. Subjects in the high STP category significantly preferred the listed sweet food items compared to low STP subjects. The correlation between sweet preference and liking for sugary foods has been reported in previous studies (Sia *et al*., 2013, Fernandaz-Carrion *et al*., 2022). The findings from the present study seem to follow a similar trend.

Nevertheless, not all of the sweet food items listed had significant differences among the subjects. This is supported by Holt *et al*. (2000) which indicates that the preferred level of sweetness is food-specific. Thus, not all types of sugary foods would be preferred by high STP subjects, as there are inter-individual variations too. In addition, another factor such as emotion also plays a role in determining preference for sweet foods. According to Kim *et al*. (2017), those who are sweet likers expressed a preference for food such as chocolate not just due to the high sweet content, but because chocolate brings positive emotional effects to them.

The findings from this study also indicate that high STP subjects significantly ($p<0.05$) preferred chicken nuggets, dried anchovies, and fried noodles compared to low and medium STP subjects. These foods were categorized as salty foods and almost half of these foods were found to be positively correlated with STP status. This observation implies that those preferring sweet foods also have a high preference for salty foods. This result was reflected in the loading plot of PCA, whereby the sweet and salty taste seems to have a close relationship. According to Fernandez-Carrion *et al*. (2022), the sweet taste was the second most preferred taste while the salty taste was the most preferred taste by the studied population. A study by Menellla *et al*. (2014) found that for both children and adults, the sweetness preference was significantly and positively correlated ($r=0.25$, $p<0.05$) with saltiness preference. This indicates that liking and preference towards sweet taste food could also motivate the liking for salty foods.

In the present study, three out of nine types of foods under the sourness category were significantly different, with high STP subjects preferring more blueberry, cranberry, and red currant juice than the low and medium STP subjects. The STP status was also correlated positively with most sour foods. Not many studies have been done to examine the relationship between sweetness preference and sour taste. Aoyma *et al*., (2017) found that sweetness sensitivity could be predicted by the preference level of sourness in food. The present study found a positive correlation between STP status and some types of sour foods. This finding could be due to variations in personal choice. The sour taste can be either pleasing or displeasing depending on the intensity and other factors (Frank *et al*., 2022). For example, sour juice contained some sugar too, thus it may not be perceived as sour as it should be. The final taste depends mostly on the interaction between the sweet and sour tastes. According to a previous study, sugar has a greater impact on reducing sourness than acid has on reducing sweetness (Stampanoni, 1993). Thus the unique sweet-sour taste interaction can be pleasant and preferred by high STP subjects.

According to a review study of flavor preference in youth versus adults, the sour taste was less preferred in general, compared to sweet and salty tastes (Hoffman, 2016). The present study supported the finding, which is reflected in the PCA loading plot. Based on the PCA plot, sweet and salty taste groups show a very close correlation, while the sour taste group however was slightly distanced from both sweet and salty tastes.

The present study shows that there was no correlation between STP status and preference for bitter taste foods. Only one food, which is cabbage showed a significant difference in the STP status. The loading plot of PCA also shows that the preference for bitter was further away from other tastes, which indicates no relationship between bitter taste and other tastes. The taste of sweet and bitter seems to be contradicted in which sweetness is perceived as pleasant, while bitterness on the other hand is perceived as bad or undesirable (Menella & Bobowski, 2015). Rather than contributing to pleasantness in eating, bitter taste warns of possible toxicity in food. Previous studies found that children have an innate preference towards sweetness and reject bitterness (Lim *et al*., 2021) and this is not due to modern-day technology or advertising, but it is a universal phenomenon based on fundamental biology (Ventura & Menella, 2011).

CONCLUSION

In general, the finding from this study indicates that the majority of subjects in this study were under the medium STP category. STP status was correlated with preferences for sweetness, saltiness, and sourness, but not bitterness. Low STP subjects had a lower preference for foods listed under the sweetness category as compared to the high STP group. High STP subjects preferred few salty and sour foods over medium or low STP subjects. The principal component analysis indicates that PC1 and PC2 explained 56.4% and 20.45% of the total variance.

ACKNOWLEDGEMENTS

This study was funded by Universiti Sains Malaysia, under the Research University (RU) grant (1001/PPSK/8012270).

ETHICAL STATEMENT

This study was approved by Human Ethical Research Committee, Universiti Sains Malaysia (USM/JEPeM/18070313).

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Aoyama, K.I., Okino, Y., Yamazaki, H., Kojima, R., Uchibori, M., Nakanishi, Y., Ota, Y., & Kaneko, A. 2017. Relationship of sex, age and preference level of sour food with sweetness sensitivity in young Japanese adults. Journal of Nutritional Health and Food Science, 5(6):1-5. https://doi.org/10.15226/jnhfs.2017.001113

Asao, K., Miller, J., Arcori, L., Lumeng, J.C., Han-Markey, T. & Herman, W.H. 2015. Patterns of sweet taste liking: A pilot study. Nutrients, 7(9): 7298-7311. https://doi.org/10.3390/nu7095336

Ashi, H., Campus, G., Forslund, H.B., Hafiz, W., Ahmed, N. & Lingstorm, P. 2017. The influence of sweet taste perception on dietary intake in relation to dental caries and BMI in Saudi Arabian schoolchildren. International Journal of Dentistry, 4262053: 1-8. https://doi.org/10.1155/2017/4262053

Cheung, M.M., Kramer, M., Beauchamp, G.K., Puputti, S. & Wise, P.M. 2022. Characterizing individual differences in sweet taste hedonics: test methods, locations, and stimuli. Nutrients, 14(2): 24-26. https://doi.org/10.3390/nu14020370

Divert, C., Chabanet, C., Schoumacker, R., Martin, C., Lange, C., Issanchou, S. & Nicklaus, S. 2017. Relationship between sweet food consumption and liking for sweet taste in French children. Food Quality and Preference, 56:18-27. https://doi.org/10.1016/j.foodqual.2016.09.009

Drewnowski, A., Menella, J.A., Johnson, S.L. & Bellisle, F. 2012. Sweetness and food preference. The Journal of Nutrition, 142: 1142S-1148S. https://doi.org/10.3945/jn.111.149575

Fernández-Carrión, R., Sorlí, J.V., Coltell, O., Pascual, E.C., Ortega-Azorín, C., Barragán, R., Giménez-Alba, I.M., Alvarez-Sala, A., Fitó, M., Ordovas, J.M. & Corella, D. 2022. Sweet taste preference: relationships with other tastes, liking for sugary foods and exploratory genome-wide association analysis in subjects with metabolic syndrome. Biomedicines, 10(1): 79. https://doi.org/10.3390/biomedicines10010079

Frank, H.E.R., Amato, K., Trautwein, M., Maia, P., Liman, E.R., Nichols, L.M., Schwenk, K., Breslin, P.A.S. & Dunn, R.R. 2022. The evolution of sour taste. Proceeding of the Royal Society B, 289: 20211918. https://doi.org/10.1098/rspb.2021.1918

Hoffman, A.C., Salgado, R.V., Dresler, C., Faller, R.W. & Bartlett, C. 2016. Flavour preferences in youth versus adults: A review. Tobacco Control, 25: ii32-ii39. https://doi.org/10.1136/tobaccocontrol-2016-053192

Holt, S.H.A., Cobiac, L., Beaumont-Smith, N.E., Easton, K. & Best, D.J. 2000. Dietary habits and the perception and liking of sweetness among Australian and Malaysian students: a cross-cultural study. Food Quality and Preference, 11: 299-312. https://doi.org/10.1016/S0950-3293(99)00076-2

Iatridi, V., Hayes, J.E. & Yeomans, M.R. 2019. Quantifying sweet taste liker phenotypes: Time for some consistency in the classification criteria. Nutrients, 11: 129. https://doi.org/10.3390/nu11010129

Jayasinghe, S.N., Kruger, R., Walsh, D.C.I., Cao, G., Rivers, S., Richter, M. & Breier, B.H. 2017. Is sweet taste perception associated with sweet food liking and intake? Nutrients, 9(750): 1-19. https://doi.org/10.3390/nu9070750

Kim, J.Y., Prescott, J. & Kim, K.O. 2017. Emotional responses to sweet foods according to sweet liker status. Food Quality and Preference, 59: 1-7. https://doi.org/10.1016/j.foodqual.2017.01.013

Li, Z., Hu, L., Rong, X., Luo, J., Xu, X. & Zhao, Y. 2022. Role of no table salt on hypertension and stroke based on large sample size from National Health and Nutrition Examination Survey database. BMB Public Health, 22: 1292. https://doi.org/10.1186/s12889-022-13722-8

Lim, L.S., Tang, X.H., Yang, W.Y., Ong, S.H., Naumovski, N. & Jani, R. 2021. Taste sensitivity and preference among Malay children aged 7 to 12 years in Kuala Lumpur - a pilot study. Pediatric Reports, 13: 245-256. https://doi.org/10.3390/pediatric13020034

Low, Y.Q., Lacy, K. & Keast, R. 2014. The role of sweet taste in satiation and satiety. Nutrients, 6(9): 3431-3450. https://doi.org/10.3390/nu6093431

Menella, J.A. & Bobowski, N.K. 2015. The sweetness and bitterness of childhood: insights from basic research on taste preferences. Physiology and Behavior, 152: 502-507. https://doi.org/10.1016/j.physbeh.2015.05.015

Menella, J.A., Finkbener, S,, Lipchock, S.V., Hwang, L.D & Reed, D.R. 2014. Preference for salty and sweet taste are elevated and related to each other during childhood. PLoS ONE, 9(3): e92201. https://doi.org/10.1371/journal.pone.0092201

Sia, B.T., Low, S.Y., Foong, W.C., Pramasivah, M., Khor, C.Z. & Say, Y.H. 2013. Demographic differences of preference, intake frequency and craving hedonic ratings of sweet foods among Malaysian subjects in Kuala Lumpur. Malaysian Journal of Medicine and Health Sciences, 9: 55-64.

Skillings, A., Mellor, D. & Harden, C.J. 2014. An exploration into the relationship between PROP taster status and the dietary intake of sugars. European Journal of Nutrition and Food Safety, 4(3):199-201.

Stampanoni, C.R. 1993. Influence of acid and sugar content on sweetness, sourness and the flavour profile

of beverages and sherbets. Food Quality and Preference, 4: 169-176. https://doi.org/10.1016/0950-3293(93)90159-4

Syathirah Hanim, A.H., Ruhaya, H., Norkhafizah, S. & Marina, A.M. 2020. Relationship between PROP (6-n-propylthiouracil) taster and preference for different taste food groups among university students. Malaysian Applied Biology, 49(5): 53-59. https://doi.org/10.55230/mabjournal.v49i5.1637

Tan, S.Y. & Tucker, R.M. 2019. Sweet taste as a predictor of dietary intake: systematic review. Nutrients, 11(94): 1-15. https://doi.org/10.3390/nu11010094

Uswatun, H. 2014. Ambang sensori rasa dasar dan preferensi dalam matriks pangan dengan pendekatan multikultural di Indonesia. (MSc). Bogor Agricultural University.

Ventura, A.K. & Mennella, J.A. 2022. Innate and learned preferences for sweet taste during childhood. Current Opinion in Clinical Nutrition and Metabolic Care, 14(4): 379-384. https://doi.org/10.1097/MCO.0b013e328346df65

Wilk, K., Korytek, W., Pelczynska, M., Moszak, M. & Bogdanski, P. 2022. The effect of artificial sweeteners use on sweet taste pereption and weight loss efficacy: A review. Nutrients, 14: 1261. https://doi.org/10.3390/nu14061261

Yang, Q., Willianson, A.M., Hasted, A. & Hort, J. 2020. Exploring the relationship between taste phenotypes, genotypes, etnicity, gender and taste perception using Chi-square and regression tree analysis. Food Quality and Preference, 83: 103928. https://doi.org/10.1016/j.foodqual.2020.103928