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DETECTION THRESHOLD AND SENSORY PREFERENCE FOR SALTY TASTE AMONG MALAY, CHINESE AND INDIAN STUDENTS IN HEALTH CAMPUS, UNIVERSITI SAINS MALAYSIA

MARINA, A.M.[1*], NURUL HUSNA, A.R.[1] and RUHAYA, H.[2]

[1]Nutrition and Dietetic Programme, School of Health Sciences, Health Campus, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan, Malaysia
[2]School of Dental Sciences, Health Campus, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan, Malaysia
[*]E-mail: mareena@usm.my

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ABSTRACT

Most dietary sodium is consumed as common salt (sodium chloride). However, high consumption of salt is highly related to several health problems such as hypertension, stroke and cardiovascular disease. The consumption of salt is related to individuals' detection threshold and preference for salty taste. Thus, this study was carried out to determine the detection threshold and sensory preference for salty taste among Malay, Chinese and Indian undergraduate students in Health Campus, Universiti Sains Malaysia. Ninety students from three ethnic groups (Malay, Chinese and Indian) were conveniently selected as panelists in this study. Detection threshold for salty taste was conducted using three-alternative force choice (3-AFC) method. Sensory preference test was conducted using a 9 point hedonic scale for saltiness in vegetable soup. Salt detection threshold for Malay, Chinese and Indian students were 1.56, 1.19 and 0.90 mM, respectively, but no significant difference was found among ethnics. Across gender, the lowest salt detection threshold was found in Indian females (0.74 mM) and Chinese males (0.70 mM). Chinese and Indian students showed a decreasing trend in salt preference as salt concentration was increased in vegetable soup. Malay students, however, demonstrated a more fluctuate trend across increasing salt concentration, with 0.5 mM as the most preferred salt concentration. Malay and Chinese male students had higher preference for saltiness compared to their females' counterpart. No relationship was found between salt detection threshold and preference for saltiness among Malay, Chinese and Indian students.

Key words: Chinese, detection threshold, Indian, Malay, preference, salt

INTRODUCTION

Salt present abundantly in nature and usually used to season or preserve food in the industry. Salt and sodium are not exactly the same, although it is often interrelated. According to American Heart Association (2016), sodium is a mineral that occurs naturally in foods or is added during manufacturing or both whereas table salt is a combination of sodium (40%) and chloride (60%).

Several epidemiological and clinical studies have demonstrated a clear relationship between salt intake and hypertension (Al-Solaiman *et al*., 2009). High salt intake has become a major risk factor related to many cardiovascular and renal diseases. High preference for high-salt food has shown to develop ample of disease such as hypertension. This is because high-salt food is able to increase the rate of blood pressure in an individual. According to National Health and Morbidity Survey (NHMS) 2015, the overall prevalence of hypertension among ethnicity in descending order is other Bumiputras (33.4%), Indians (32.4%), Malay (31.1%) and Chinese (30.8%) (Institute for Public Health, 2015). The adult population is recommended to consume less than 2000 mg of sodium which is equivalent to 5 grams of salt per day according to the new guidelines issued by World Health Organization (WHO) (WHO, 2012). According to the Malaysian Adult Nutrition Survey 2014 (Institute for Public Health, 2014), the median sodium intake among Malaysian adults is 1935 mg/day.

* To whom correspondence should be addressed.

Since hypertension is related to salt intake, the factors that related to salt intake are therefore indirectly affected hypertension. Sensory taste perception for saltiness affects the amounts of salt individuals consume. The strategy to reduce salt intake will be difficult to achieve if an individual is insensitive to salty taste. Therefore, it is worth to study the sensory profile of individuals towards salty taste to determine their sensitivity towards salty taste. Detection threshold test can indicate the sensitivity of individuals towards salty taste while sensory preference test shows their preference for salt content in foods.

Cocores and Gold (2009) found that adolescents tend to prefer higher levels of salt compared with adults and Cowart (2011) reported that the importance of sensory context in item-specific preferences established during childhood and continues until adolescence. Both adolescents and adults are exposed to greater sensory exposure compared to young children. Previous studies have found that restricted sensory exposure decreases appetite whereas greater sensory exposure will increase appetite.

The level of salt detection threshold of a person plays an important role in his or her health. Previous research has shown that individuals who have high detection threshold for salt taste sensitivity tend to eat saltier food than those who have low detection threshold for salt (Jiang *et al*., 2016). In the present study, salt detection threshold and preference among major ethnics in Malaysia (Malays, Chinese and Indians) were assessed which focused on undergraduate university students. The subjects were chosen in this study because sodium intake was found to be the highest in the group with the highest educational level (2734 mg/day for college/ university students) compared to other groups (Mitchell, Brunton & Wilkinson, 2013). It is hoped that this study would create awareness among the population about the relationship between high-salt intake and high-salt related disease.

MATERIALS AND METHODS

Sensory panel

A cross sectional study, which involved 90 undergraduate students (untrained panels) of Health Campus, Universiti Sains Malaysia were carried out. The sampling method used was convenience sampling. Students who had used tobacco product and had medical condition or evidence of conditions that could alter gustatory sense were excluded. All research procedure was approved by the Ethical Research Committee, Universiti Sains Malaysia (USM/JEPeM/16110436). The number of panelists for each ethnic group was chosen as 30, by referring to the sensory threshold testing method ASTM E679 (suggested between 23 to 35) (ASTM, 2011).

Sensory determination

Detection threshold

The detection threshold for salty taste was determined using three-alternative forced-choice (3-AFC) method according to ASTM E679 (ASTM, 2011). In this method, panelists were provided with three samples containing a salt solution and two samples of pure water. Panelists were asked whether they perceived a taste sensation different from the water. The lowest concentration at which panelist tasted a difference to the water sample was considered as threshold concentration.

Salt solution was prepared according to Uswatun (2014) which were 0.31, 0.63, 1.25, 2.50, 5.00 and 10.00 mM. There were six sets of salt concentrations. Each set of salt concentration consisted of a cup of salt solution and two cups of water or blank (10 ml) presented in a small disposable cup and coded with randomly three digit numbers.

One hour before the testing, panelist was asked not to eat, drink or brush their teeth. It is essential to avoid bias due to the difference in sensitivity of sense of taste. A tray consisted of six sets of salt concentrations were presented in front of the panelists. The samples were presented from the lowest to the highest concentration. Before testing, panelists were asked to gargle first. Panelists were allowed to repeat the testing in the same concentration set if they were not confident of the answer. Panelists were required to provide the answer for each concentration, before proceeding to the next higher concentration set. Before testing the next set of samples, they were required to rinse their mouth with tap water.

Sensory preference

Sensory preference test was conducted by using hedonic test. A 9-point hedonic scale was used in this study to determine the preference level for salt concentration in vegetable soup. The scale of 1 represented dislike extremely and 9 represented like extremely. Subjects were asked to place a rating preference for each of six concentration of salt in the vegetable soup that they tasted. The sensory preference score was obtained by calculating the average mean preference score for each concentration. Preferred concentration for each individual in this study refers to the concentration with the highest preference rating.

The vegetable soup was chosen for salt preference because the dish was familiar to subjects and involved little preparation. The vegetable soup was prepared by adding vegetables namely carrot, parsley and celery into boiling water and cooked to perfection. Once cooked, the vegetable soup was filtered to obtain only the clear soup which was used to serve the panelists. The vegetable soup was divided into six and added with different concentration of salt. The concentrations of salt used were 0.38, 0.50, 0.61, 0.75, 0.88 and 1.00 mM (Uswatun, 2014). The vegetable soup was stirred until salt dissolved completely.

The vegetable soup was served in disposable cups (15ml) and coded with randomly three digit numbers. The position of each cups was randomly placed, not according to the order of concentration. The samples for tasting were performed sequentially from left to right. After tasting the first samples, the panelists were required to indicate how much they like the samples based on the saltiness intensity of the sample. Before tasting the next set of samples, they were required to rinse their mouth with tap water.

Statistical analysis

The series of each panelist's judgment for detection threshold was expressed as (0) for an incorrect choice and (+) for a correct choice arranged in the order of ascending concentration. The detection threshold was measured using the best-estimation threshold (BET). This is a method of estimation threshold of stimulation by using geo-mean of concentration in which the last miss occurred (0) and the next higher concentration designated by a (+). Geo-mean was obtained from the following equation:

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

The BET individual score was calculated by each individual. The average values of the total logBET individual were then calculated to get the BET group for Malay, Chinese and Indian panelists. BET group was derived by geometrical averaging of BET individual.

The data collected were analyzed using the Statistical Package of Social Science (SPSS) Version 22. The P value of < 0.05 was considered statistically significant. The significant difference in detection threshold and sensory preference for saltiness among three ethnic groups was analyzed using the Kruskal-Wallis test. The Man Whitney test was used to determine the significant difference in salt detection threshold and sensory preference among gender. The relationship for sensory detection threshold and preference for saltiness was analyzed using Spearman's correlation.

RESULTS

Table 1 shows the detection threshold for saltiness among Malay, Chinese and Indian students. Indian (0.90 mM) had the lowest while Malay (1.56 mM) students had the highest detection threshold for salty taste among ethnics. However, there was no significant different ($P > 0.05$) between Malay, Chinese and Indian students in the detection threshold for salty taste. In terms of gender, males had lower detection threshold for saltiness than females in Malay and Chinese ethnics but Indian females scored lower detection threshold than their males' counterpart.

The preference score for saltiness in vegetable soup among different ethnics is shown in Figure 1. Both Indian and Chinese students gave the highest preference score for the lowest salt concentration (0.38 mM) while Malay students preferred the next higher concentration (0.50 mM). The saltiness preference scores for Malay students were more fluctuate compared to other ethnics. The saltiness preference scores for Chinese and Indian students showed a decreasing trend; in which the highest preference score was assigned to the lowest salt concentration while the lowest preference score was assigned to the highest salt concentration in vegetable soup. There was no significant different

Table 1. Detection threshold for salty taste among Malay, Chinese and Indian students

Ethnicity	Group Best Estimated Threshold (BET) for saltiness (mM)		
	Total	Female	Male
Malay	1.56 ± 0.96	2.26 ± 0.94	0.91 ± 0.97
Chinese	1.19 ± 0.89	1.69 ± 0.93	0.70 ± 0.83
Indian	0.90 ± 1.06	0.74 ± 1.11	1.73 ± 0.91

P value = 0.686.

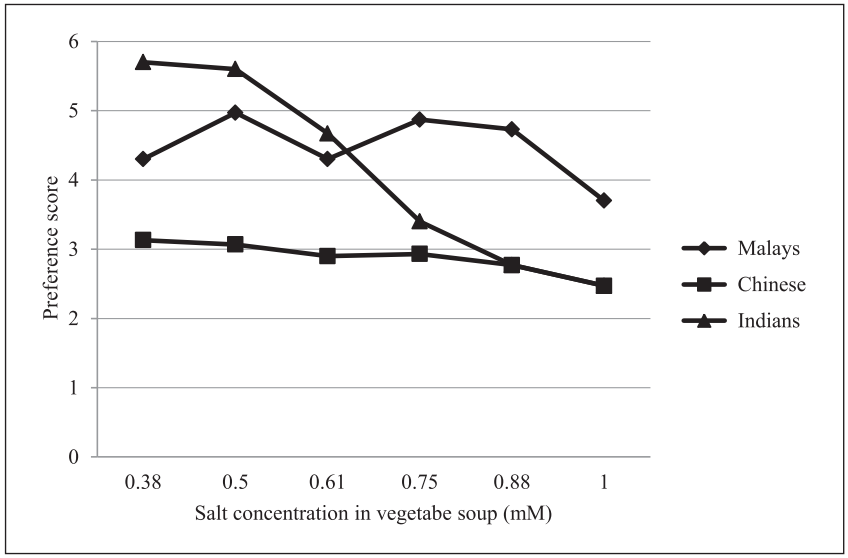

Fig. 1. Sensory preference for salty taste in vegetable soup among Malay, Chinese and Indian students (P = 0.06).

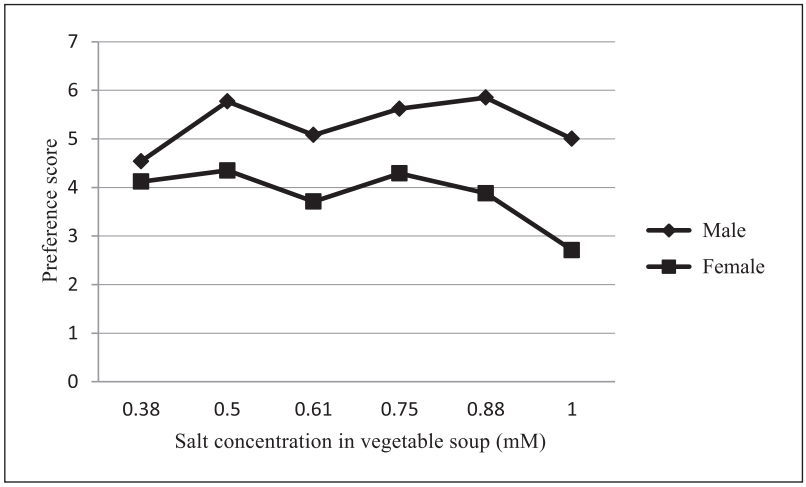

Fig. 2. Sensory preference for salty taste in vegetable soup among Malay students (P = 0.43).

(P > 0.05) between preferred concentration for salty taste among Malay, Chinese and Indian students.

Figure 2 shows the preference score for saltiness in vegetable soup among Malay students according to gender. Malay males scored higher preference than females for all of the salt concentrations. Malay males allocated the highest preference score for the salt concentration of 0.88 mM while Malay females preferred less salty soup (0.50 mM). According to Figure 3, Chinese males preferred vegetable soup the most at concentration of 0.75 mM. Chinese females, on the other hand, did not prefer much salt in their soups. The higher the salt concentration in the vegetable soup, the lower the preferences score assigned by the Chinese females. Indian females followed the same preference pattern as Chinese females (Figure 4). Indian males preferred vegetable soup the most at salt concentration of 0.5 mM but the preference score slowly declined afterward.

There was no significant different (P > 0.05) between the preferred concentration of salty taste among male and female students. There was also no significant relationship between the detection threshold and preferred concentration for salty taste (r = -0.132, p > 0.05) among the students.

DISCUSSION

The salt detection thresholds obtained in the present study (0.90 – 1.56 mM) were consistent with findings by Hatae *et al*. (2009) and Uswatun (2014)

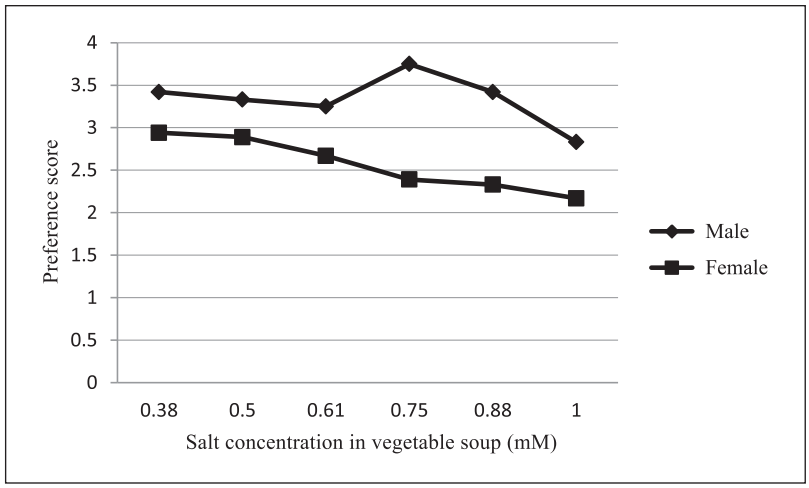

Fig. 3. Sensory preference for salty taste in vegetable soup among Chinese students (P = 0.71).

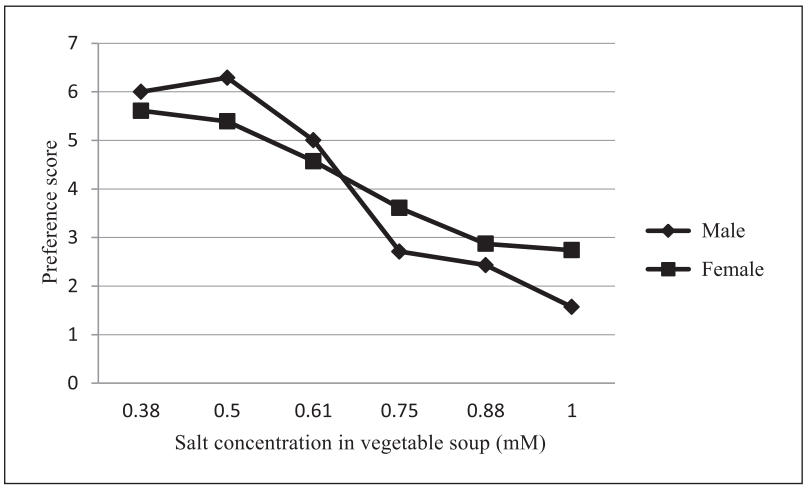

Fig. 4. Sensory preference for salty taste in vegetable soup among Indian students (P = 0.49).

with salt detection threshold obtained in those studies were 0.719 and 1.982 mM, respectively. The present study shows that Indian students had the lowest detection threshold for saltiness, followed by Chinese and Malay students. The lower detection threshold indicates higher taste sensitivity towards salty taste. However, the result shows that there is no significant difference in the detection threshold for saltiness among Malay, Chinese and Indian students. Consuming a low sodium diet has the potential to increase sensitivity towards salt and increase preference for low sodium foods. However, several studies reported that taste sensitivity might change depending on bodily needs (Bartoshuk & Beauchamp, 1994).

The present study indicates that male students from Malay and Chinese groups had lower detection threshold for saltiness, compared to females, but the result was not significant. This is in contrast to the study conducted by Uswatun (2014) which found that female subjects had significantly lower detection threshold for salt, compared to male subjects. Another study conducted by Michelle *et al*. (2013) also reported that there was a significant difference between males and females in salt detection threshold aged between 22-56 years old subjects. Differences in the detection threshold might be influenced by some other factors such as age, experience as well as exposure to foods.

The present study found that Indian students had the highest preference for the lowest salt concentration in vegetable soup, as compared to Malay and Chinese students. The preference score continued to decline as the salt concentration increased. This indicates that Indian students do not prefer much salt in their foods. Although not significant, Indian students also were generally most sensitive to salty taste, as indicated by their lowest

detection threshold for saltiness. Earlier research suggested a connection between an individual's salt taste sensitivity and their acceptance and consumption of sodium rich foods (Mitchell *et al*., 2013). This is supported by Choong *et al*. (2012) in a study between Chinese and Indians, which found that Indians consumed less sodium than Chinese. According to the Malaysian Adult Nutrition Survey 2014 (Institute of Public Health, 2014), among the three ethnics, Chinese consumed the most salt, followed by Indians and Malays. However, according to the National Health and Morbidity Survey (NHMS) 2015, the overall prevalence of hypertension among Chinese was the lowest among all ethnics (Institute for Public Health, 2015). This shows that the relationship between the consumption of salt and hypertension is not always positive or straight forward, but more complex as hypertension is a multifactorial complication. For example, a study among French adults found that age-adjusted systolic blood pressure was not significantly associated with salt consumption in women, and not associated with either gender after multiple adjustments (Lelong *et al*., 2015).

In terms of gender, male students had a higher salt preference score in Malay and Chinese ethnics. This result might be due to several factors such as genetic, environmental and their culture of eating. According to Boek *et al*. (2012), male students were more likely to choose unhealthy foods which contain sodium over high fat foods, as compared to female students even though both male and female students chose high fat foods as the primary determinants of unhealthy foods. This is also supported by finding of Malaysian Adults Nutrition Survey 2014 (Institute for Public Health, 2014), which reported that Malaysian men had a higher median intake of sodium compared to women. According to Choong *et al*. (2012), both genders preferred western based salty foods, but male subjects showed a higher intake of these salty foods compared to female subjects.

In another study, it was found that across gender and ethnicities, the saltiness intensity perception increased as the sodium content of solutions or food increased (Hayes *et al*., 2010). In that particular study, the intensity of the foods that generally 'tasted less salty' was not perceived as significantly different among gender and ethnicity, but females perceived foods that 'tasted saltier' significantly higher than males, which supported some findings that indicated women perceived significantly more saltiness from high-sodium foods compared to men. In a study done by Mojet *et al*. (2003), women also reported a larger difference in perceived intensity for sodium chloride and potassium chloride concentration.

According to Baharuddin and Sharifudin (2013), there was a significant correlation between taste threshold and preferred concentration for saltiness among Kadazandusun ethnic in Sabah. However, the present study established no relationship between salt detection threshold and preference for saltiness. This is probably due to the small sample size. Similar to the present study, Mitchell *et al*. (2013) found no association between salt detection threshold and vegetable soup acceptability scores. It is proposed that the sensitivity to salt is different between salt in water solution and salt in more complex food such as vegetable soup. Thus, an individual's sensitivity to salty taste does not necessarily make a difference in their preference for salty taste in foods they consumed (Uswatun, 2014).

Lucas *et al*. (2011) also found no association between sodium intake and parameters such as salty taste recognition thresholds, liking and perceived intensity. The impact of saltiness on liking is quite complex and it has been suggested that hedonic responses to differing sodium concentrations might be food specific (Hayes *et al*., 2010). The relationship between the detection threshold and preference for saltiness might also be influenced by some factors such as genetic factors and environmental factors.

CONCLUSION

In conclusion, the current findings showed that no significant different established in salt detection threshold between different ethnics. There is also no relationship between salt detection threshold and preference for saltiness among Malay, Chinese and Indian students. Although not significant, the Indian students generally had the lowest salt detection threshold and the lowest preference for salty taste. In addition, male students tend to give a higher score in salt preference as compared to female students. Since salt is the primary cause of salty taste, a complete understanding of the factors that contribute to salt consumption is needed in order to develop an efficient strategy to reduce salt intake. For example, the salt reduction in food products needs to be carried out gradually after appropriate adjustment with the sensory preference for salt.

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