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Food Science

BITTER TRUTHS: EXPLORING THE TASTE PERCEPTION AND CONSUMPTION BEHAVIOR

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Abstract

Individual choice of food and consumption are influenced by many factors, including cultural, socio-economic, environmental, and personal factors or genetics, which make every individual different from others. The genetic factor controls the individual's taste perception; among them, the TAS2R38 gene controls the bitter taste sensitivity. The variations in this gene differentiate people into bitter tasters or supertasters and non-tasters. Bitter tasters are highly sensitive to bitter-tasting foods and vegetables, which may lead them to avoid these foods and consequently hinder their ability to follow healthy eating habits. This cross-sectional study aimed to determine the percentage of bitter tasters among young adults and explore the influence or association of bitter taste sensitivity on their food consumption behavior. In this study, there was no difference in other flavor preferences, like more sweet or salty food, between bitter tasters and non-tasters. There was also no difference in choice of food and cooking method apart from the seasoning added to the fast food. Bitter tasters added less seasoning in the fast food compared to the bitter non-tasters, although no difference was seen in adding seasoning to rice and noodles. This study showed that other factors like cultural and environmental factors could influence the difference between bitter tasters and non-tasters.

Keywords: Bitter taste perception, Consumption Behavior, Thai Young Adults

Introduction

Humans have used taste perception as a tool to identify and differentiate safe and toxic food for their growth and longevity. Sweet taste and umami taste were used to identify the nutritious food for energy intake. More importantly, humans used the bitter taste sensation to avoid poisonous and toxic food long ago (Roper, 2017). In the previous century, the whole world has developed a lot in every aspect, including the development of new products in food industries and lifestyle changes. In the meantime, food intake behavior has changed, starting in developed countries and later in middle and even low-income countries, with a preference for calorie-dense food over nutrient-rich food (Nasreddine et al., 2018). As a result, the health figures of people in both developed and developing countries changed tremendously with the increasing prevalence of non-communicable diseases like obesity, diabetes, hypertension, heart disease, stroke, and cancer at an explosive rate (Mendoza et al., 2007).

Taste perception occurs when the chemicals dissolved in the food particles come into contact with the taste receptors on the taste buds on the tongue and the oral cavity. Taste perception makes the preference for sweet taste over sour or bitter taste an innate taste sensitivity (Ventura & Worobey, 2013). People with high sensitivity to bitter tastes avoid eating vegetables with bitter taste and prefer to eat calorie-dense sweet foods. Moreover, bitter taste sensitivity is controlled by the bitter taste

gene, which is variable in different ethnic populations (Tepper, 1998). It is hypothesized that genetically positive bitter tasters are prone to eating more sweet food and avoiding vegetables. In the Thai population, having a culture of preference for sweet and salty food and whether this consumption behavior is related to bitter taste sensitivity or not, as well as the prevalence of bitter tasters in young adult, still need to be found. The answers to these questions will be the first step of the basic ethnic and cultural data. They will be useful for plans for lifestyle changes and healthy eating habits to prevent non-communicable diseases.

Research Objectives

1. To identify the percentage of bitter taste sensitivity in young adult
2. To identify the association between bitter taste sensitivity and consumption behavior in Thai young adults

Literature Review

1. Bitter Taste Perception

The difference in taste perception for bitter taste was accidentally found by Fox (Fox, 1932) while synthesizing Phenylthiocarbamide (PTC) in the laboratory in 1931. Some people could taste PTC as bitter, while others could not. People who could taste PTC were designated as bitter tasters, and those who could not were bitter non-tasters. The percentage of bitter non-tasters varies among different ethnic populations: 5-15% in Japanese (Sato et al., 1997), 20% in Koreans (Hong et al., 2005), approximately 30% in Caucasians, and more than 40% in Indians (Levine & Anderson, 1932). Bitter taste perception is influenced by many factors like age, sex, diseases, and drugs (Rademacher et al., 2020).

2. Bitter Taste Gene and Receptor

Bitter taste perception occurs through the G-protein-coupled receptors located on the tongue, soft palate, oropharynx, larynx, and esophagus. These receptors are controlled by the TAS2R38 gene located on chromosome number 7. Single nucleotide polymorphism causes variation in the TAS2R38 gene in each individual, leading to different bitter taste sensitivity and differentiation as supertasters, medium tasters, and non-tasters (Bachmanov & Boughter, 2012).

3. Bitter Taste Perception and Bitter Food and Vegetable Intake

Regarding the bitter taste, bitter non-tasters tend to consume more bitter cruciferous vegetables than tasters. However, the survey done in the USA population found no significant difference in fruit and vegetable intake between bitter tasters and non-tasters (Alardawi et al., 2020). Bitter tasters feel the caffeine is more bitter than non-tasters, and they add more cream and sugar to the coffee, but there was no difference in consumption of coffee and chocolate between the groups (Ly & Drewnowski, 2001). In a meta-analysis of the association between bitter taste sensitivity and vegetable consumption, no difference was detected between the groups (Bawajeeh et al., 2020). As consuming cruciferous green vegetables becomes important for preventing colon cancers (Wu et al., 2013) and other metabolic diseases, bitter taste sensitivity plays an important role in food consumption and lifestyle changes.

Methodology

1. Study Design and Participants

This study was a cross-sectional analytical study of healthy young adults from 18 to 40 years of age, and the participants were recruited from the Bangkok Metropolitan region by a convenience sampling method. Young adults who had a history of chronic diseases like heart failure, hypertension, diabetes, liver diseases, renal diseases, and cancers were excluded. Pregnant women and lactating mothers were also excluded. Subjects who had a diagnosis of mental health problems and had been taking antidepressants were excluded from this research. Participants experiencing dry mouth or phantom taste perception, such as ageusia, dysgeusia, or hypogeusia, were excluded from the study. Those who were taking drugs like antihypertensives, antidiabetics, diuretics, and recently taking antibiotics that can modify taste perceptions were removed from this research, but taking vitamins, minerals, and oral contraceptive pills was not excluded. Any history of chronic smoking (history of smoking at least 100 cigarettes) or chronic alcohol drinking with physical dependence was also excluded as they are related to changes in taste sensitivity. Participants with incomplete data and incomplete eating habit questionnaires or who did not finish all the tests were excluded. This study was conducted following the World Medical Association Declaration of Helsinki and under ethical approval from the Institutional Review Board (IRB) regulations of Mahidol University (MU-CIRB 2023/039.2003), and written informed consents were taken from all the participants.

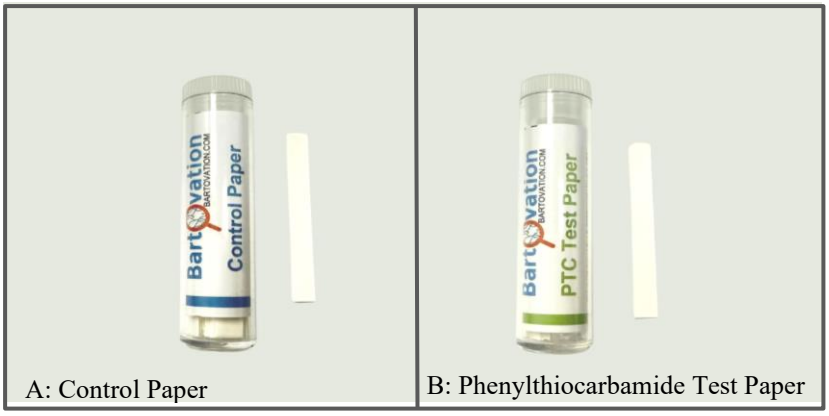
The sample size was calculated using the correlation between bitter taste sensitivity and preference for vegetables in previous research (Hald et al., 2021). By setting the type I error at 0.05 and the power at 80% (β=0.2), the sample size required for this research was 167, with an additional 10% added to account for an incomplete rate, resulting in a total of 186.

2. Data Collection

After registration, participants were provided with information sheets and informed consent forms, which they signed after reading and fully understanding the information. Participants first completed the screening questionnaires to assess exclusion criteria, followed by the demographic data and eating habits questionnaires. After they had completed the questionnaires, participants proceeded with the bitter taste test. Their height (cm) and weight (kg) were measured to the nearest 0.1 unit, and BMI was assessed using a Bioelectrical Impedance Analysis (BIA) machine (Omron HBF-375, Japan). Participants were first asked to empty their bladders before the measurement. They were then asked to remove all metallic accessories, such as watches, bracelets, and belts, which could interfere with the electric current flow. Participants also removed their socks and stood barefoot on the machine, holding the handle with their arms extended at a 90-degree angle to their bodies. They remained still for approximately one minute until the calibration was complete.

3. Bitter Taste Sensitivity Test or Phenylthiocarbamide (PTC) Test

A bitter taste sensitivity test was done by placing the PTC test paper on the tongue until it became wet with saliva (about 30 seconds) and then removing it. Participants first tasted the control paper, followed by the test paper. Individuals who perceived the PTC as bitter were classified as bitter tasters, while those who did not were classified as bitter non-tasters.



Picture 1: Bitter taste test kit

4. Statictical Analysis

Statistical Package for the Social Sciences (SPSS) software license version 25.0 (SPSS Inc., Chicago, Illinois, USA) was used for data analysis. Frequency and percent were calculated for qualitative data on the demographics and eating habits of the participants. Mean plus standard deviation was calculated for quantitative data like age and BMI. The bitter taste perception was analyzed in terms of the percentage of individuals categorized as tasters or non-tasters. The differences in bitter taste perception between sex, age, marital status, education, and income were assessed. The differences in consumption behavior between bitter tasters and non-tasters were determined using the chi-square (χ^2) test, Cramer's V, and Mann-Whitney's U test, depending on the variables based on the distribution of the variables (normal or abnormal).

Results

Two hundred and thirty-six participants from the Bangkok metropolitan area enrolled and registered in the project. After removing 19 participants with incomplete data, 6 with chronic diseases like hypertension, diabetes, and depression, and 2 chronic smokers, 209 participants were eligible for data analysis. After testing for normality, 17 outliers with energy intake less than 500 kcal and over 5000 kcal were excluded, which resulted in 192 participants left for final analysis.

1. Bitter Taste Test

In a total of 192 participants, the majority of individuals in the sample population (166 individuals), constituting 86.5% of the total sample, perceived the PTC solution as bitter. In contrast, a smaller proportion of 13.5 % were bitter non-tasters.

Table 1: Bitter Taste (PTC) Test Result

PTC Test	Overall (192)
Bitter	166 (86.5)
Non Bitter	26 (13.5)

Data were presented as n (%)

2. Demographic Characteristics of the Participants

The personal and demographic information of the participants is shown in Table 2. There were 127 females (66.1%) and 65 males (33.9%) involved in this research. Most of the participants (69.8%) were under 25 years old, and the mean age of the participants plus the standard deviation (mean ± SD) was 23.9±6.2. Nearly half (46.4%) of the participants had a normal BMI, whereas 13.5% were underweight, 15.6% were overweight, and 24.5% were obese. The average BMI (mean ± SD) of the participants was 22.8±4.5. Most of the participants (174) were single, which constituted 90.6% of the participants; 16 were married, one was separated, and one was widowed. As a large portion of the participants were university students, high school education constituted 41.1%, with diplomas (0.5%), bachelor's (41.7%), master's (13%), and others (PhD) (3.6%) as the highest level of education. Nearly two-thirds (66.1%) of the participants had an income of less than 15000 baht as they were undergraduate students, and one-third (33.9%) had an income higher than 15000 baht.

Table 2: Demographic Characteristics and Bitter Taste Perception of the Participants

Characteristics	Overall (192)	Bitter Taster (166)	Bitter Non-taster (26)
Gender, n (%)			
Male	65 (33.9)	58 (34.9)	7 (26.9)
Female	127 (66.1)	108 (65.1)	19 (73.1)
Age, years	23.9±6.2	23.7±6.0	25.4±7.3
Age, n (%)			
18-20 years	80 (41.7)	70 (42.2)	10 (38.5)
21-25	54 (28.1)	48 (28.9)	6 (23.1)
26-30	28 (14.6)	23 (13.9)	5 (19.2)
31-35	15 (7.8)	14 (8.4)	1 (3.8)
36-40	15 (7.8)	11 (6.6)	4 (15.4)
BMI, kg/m^2	22.8±4.5	22.9±4.6	22.4±4.1
BMI -based classes[¥], n (%)			
Underweight (<18.5 kg/m^2)	26 (13.5)	24 (14.5)	2 (7.7)
Normal (18.5-22.9 kg/m^2)	89 (46.4)	74 (44.6)	15 (57.7)
Overweight (23.0-24.9 kg/m^2)	30 (15.6)	28 (16.9)	2 (7.7)
Obese (≥25.0 kg/m^2)	47 (24.5)	40 (24.1)	7 (26.9)
Marital Status, n (%)			
Single	174 (90.6)	152 (91.6)	22 (84.6)
Married	16 (8.3)	13 (7.8)	3 (11.5)
Divorce	0 (0)	0 (0)	0 (0)
Separated	1 (0.5)	0 (0)	1 (3.8)
Widow	1 (0.5)	1 (0.6)	0 (0)
Highest Education, n (%)			
High School	79 (41.1)	70 (42.2)	9 (34.6)
Diploma	1 (0.5)	0 (0)	1 (3.8)
Bachelor's Degree	80 (41.7)	68 (41.0)	12 (46.2)
Master's Degree	25 (13.0)	22 (13.3)	3 (11.5)
Others	7 (3.6)	6 (3.6)	1 (3.8)
Average Income Per Month, n (%)			
0-5000	49 (25.5)	37 (22.3)	12 (46.2)
5001-10000	45 (23.4)	41 (24.7)	4 (15.4)
10001-15000	33 (17.2)	30 (18.1)	3 (11.5)
15001-20000	14 (7.3)	14 (8.4)	0 (0)
20001-25000	19 (9.9)	17 (10.2)	2 (7.7)
Above 25000	32 (16.7)	27 (16.3)	5 (19.2)

Qualitative data is expressed as n (%) and quantitative data as mean ± SD

[¥] The BMI category is based on Asia-Pacific criteria.

3. Eating Habits / Consumption Behavior

To get information regarding the consumption behavior or eating habits of Thai people, sixteen questions about daily habits were asked. These involved the number of meals eaten every day, the flavor of food like most, the level of sweetness, the level of saltiness, preference for bitter food or not, the source of food, the method of cooking mostly used in daily cooking, consideration in purchasing food, limitation on seasoning in cooking, adding seasoning to noodles, adding seasoning to rice, adding seasoning to fast food, ladles of rice eaten in each meal, tablespoons of meat eaten in each meal, ladles of vegetables usually eaten per day, and servings of fruits eaten per day.

Half of the participants (50%) reported eating only two meals per day, while 47.4% ate three meals daily. Only 1% consumed one meal every day, and 1.6% ate more than three meals per day. The salty flavor was preferred by 20.3% of participants, followed by spicy (17.2%), sweet (12%), plain (10.9%), and sour (7.8%). Additionally, 31.8% of participants (61 individuals) reported liking more than one flavor. Regarding the level of sweetness preferred, more than half of the participants (52.1%) liked the medium sweet, and 44.3% liked the less sweet. Only a small percentage of subjects (3.6%) liked very sweet tastes. For the salty taste, nearly two-thirds of the participants preferred a salty taste (62%), while about one-third liked a less salty taste (32.3%). Only 6.7% liked the very salty taste. More than two-thirds (68.8%) of the participants were afraid of bitter food, while the rest accepted the bitter taste.

Fifty-eight participants (30.2%) obtained their food by eating out. In comparison, 55 individuals (28.6%) prepared their own meals, 47 participants (24.5%) purchased food from the shops or markets, 5 participants (2.6%) consumed ready-made meals, and 27 participants (14.1%) selected “others”, explaining that they either bought pre-cooked food or had someone cook for them. The remaining participants indicated that they sourced their food using multiple methods, such as cooking at home, eating out, or buying from shops or markets, depending on the situation. Half of the participants (50%) selected stir-fry as their preferred cooking method for daily meals, while 19.3% chose boiling and 10.9% preferred frying. Only a small percentage chose grilling (4.7%), half-cooking (1.6%), or baking (1.6%). The remaining participants (11.9%) selected multiple cooking methods, which included boiling, steaming, frying, baking, stir-frying, and grilling.

Twenty-eight percent of the participants bought the food depending on their appetite and 17.7% on taste. Some of the subjects (13.5%) considered the price first, as they were the students who got money from their parents and limited their spending. Some (10.9%) considered nutrients first, which showed they had some nutrition knowledge, and some (10.9%) bought the food with preference. A small percentage of subjects (7.4%) considered hygiene first before they purchased food as they were concerned about infection, and 3.6% thought about convenience first. One participant considered whether the food was worth buying or not, depending on the quality, nutrients, and price. The other subjects (6.7%) considered more than one factor before they bought food.

As most of the participants are university students, 29.2% of the subjects did not cook food, while 30.7% cooked without limitation of all seasoning in food, and 40.1% cooked and limited all seasoning. More than half of the subjects (57.8%) added seasoning to their noodles. Most of them added chili and vinegar to the noodles. Some added fish sauce and sugar. Some participants added all four seasonings to their noodles. More than 75% of the participants did not add any seasoning to rice, and 21.4% added seasoning. They added fish sauce, fish sauce, and chili or soy sauce to the rice. Most of them added one teaspoon, but some added 2 teaspoons. More than half (59.9%) of the participants did not add anything to fast food, and 39.1% added seasoning. Among people who added seasoning to fast food, 80% added tomato sauce, followed by chili sauce (46.7%).

Approximately half of the participants (51.6%) consumed two ladles of rice per meal, while 15.6% ate three ladles of rice. 57 participants (29.7%) ate only one ladle of rice, and 5 participants ate 4 or more ladles of rice. The participants ate 2 (14.6%), 3 (30.2%), and 4 (25.5%) tablespoons of meat in every meal, and some ate as much as 5 tablespoons (7.8%) and 6 tablespoons or more (19.3%) in every meal. Higher consumption of meat was found, especially in male participants. The frequency and percentage of participants eating meat are shown in detail in Table 3.

The participants reported consuming one (25.5%), two (34.9%), three (22.4%), and four (9.4%) ladles of vegetables daily. Additionally, 3.1% ate five ladles, while 4.2% did not eat vegetables at all. The data showed that 38% of the participants met the WHO guidelines of consuming at least three servings of vegetables per day, while 62% consumed less. Regarding fruit intake, only 15.6% of participants met the WHO recommendation of at least 3 servings of fruits per day, while 70.4% ate less than the WHO-recommended amount, and 13.5% did not eat any fruits.

Bitter taste sensitivity was not variable among different age and BMI groups. The consumption behavior between bitter tasters and non-tasters showed no significant differences in the number of meals eaten per day, flavor preferences, sweetness and saltiness preferences, acceptance of bitter taste, food sources, cooking methods used in daily cooking, consideration when purchasing food, and limitation of seasoning. Seasoning added to the rice and noodles was not different between bitter tasters and non-tasters. Interestingly, seasoning added to the fast food was found to be significantly different between the two groups. Around one-third of bitter tasters added seasoning to fast food, while nearly two-thirds of the bitter non-tasters added seasoning ($p = .012$). There was no significant difference in rice, meat, fruit, and vegetable consumption between the bitter tasters and non-tasters groups.

Table 3: Differences in Consumption Behavior between Bitter Tasters and Bitter Non-tasters

Eating Habits/Consumption Behavior	Overall (192)	Bitter (166)	Not Bitter(26)
1. Number of meals per day			
3 meals a day	91 (47.4)	78 (47.0)	13 (50.0)
2 meals a day	96 (50.0)	83 (50.0)	13 (50.0)
1 meal a day	2 (1.0)	2 (1.2)	0 (0)
More than 3 meals a day	3 (1.6)	3 (1.8)	0 (0)
2. Flavor of food like most			
salty	39 (20.3)	32 (19.3)	7 (26.9)
spicy	33 (17.2)	33 (19.9)	0 (0)
sweet	23 (12.0)	21 (12.7)	2 (7.7)
plain	21 (10.9)	20 (12.0)	1 (3.8)
sour	15 (7.8)	13 (7.8)	2 (7.7)
More than one taste	61 (31.8)	47 (28.3)	14 (53.8)
3. Level of sweetness preferred			
Less sweet	85 (44.3)	76 (45.8)	9 (34.6)
Medium sweet	100 (52.1)	83 (50.0)	17 (65.4)
Very sweet	7 (3.6)	7 (4.2)	0 (0)
4. Level of saltiness prefer			
Less salty	62 (32.3)	52 (31.3)	10 (38.5)
Salty	119 (62.0)	105 (63.3)	14 (53.8)
Very salty	11 (5.7)	9 (5.4)	2 (7.7)
5. Preference of bitter food			
Yes	60 (31.3)	51 (30.7)	9 (34.6)
No	132 (68.8)	115 (69.3)	17 (65.4)

Eating Habits/Consumption Behavior	Overall (192)	Bitter (166)	Not Bitter(26)
6. Source of food			
Eat outside	58 (30.2)	53 (31.9)	5 (19.2)
Cooks by self	55 (28.6)	46 (27.7)	9 (34.6)
Buy from the shop or market	47 (24.5)	41 (24.7)	6 (23.1)
Ready-made foods	5 (2.6)	5 (3.0)	0 (0)
Others (precooked food or more than one source)	27 (14.1)	21 (12.7)	6 (23.1)
7. Cooking method used in daily cooking			
Stir-fried	96 (50.0)	78 (47.0)	18 (69.2)
Boiling	37 (19.3)	33 (19.9)	4 (15.4)
Fried	21 (10.9)	18 (10.8)	3 (11.5)
Grill	9 (4.7)	8 (4.8)	1 (3.8)
Half-cooked	3 (1.6)	3 (1.8)	0 (0)
Baking	3 (1.6)	3 (1.8)	0 (0)
Steaming	0 (0.0)	0 (0)	0 (0)
Other (more than one method)	23 (11.9)	23 (13.9)	0 (0)
8. Consideration in purchasing food			
Appetite	55 (28.6)	46 (27.7)	9 (34.6)
Taste	34 (17.7)	28 (16.9)	6 (23.1)
Price	26 (13.5)	24 (14.5)	2 (7.7)
Nutrient	21 (10.9)	16 (9.6)	5 (19.2)
Preference	21 (10.9)	20 (12.0)	1 (3.8)
Hygiene	14 (7.4)	12 (7.2)	2 (7.7)
Convenience	7 (3.6)	7 (4.2)	0 (0)
Other (worth to buy or consider more than one)	14 (7.4)	13 (7.8)	1 (3.8)
9. Limitation on seasoning use			
No cooking	56 (29.2)	45 (27.1)	11 (42.3)
Cooking and no limit on all seasoning	59 (30.7)	51 (30.7)	8 (30.8)
Cooking and limit all seasoning	77 (40.1)	70 (42.2)	7 (26.9)
10. Add seasoning to noodle			
Not add anything	81 (42.2)	73 (44.0)	8 (30.8)
Add seasoning to noodle	111 (57.8)	93 (56.0)	18 (69.2)
11. Add seasoning to rice			
Not add anything	149 (77.6)	127 (76.5)	22 (84.6)
Add seasoning	41 (21.4)	37 (22.3)	4 (15.4)
12. Add seasoning to fast-food			
Not add anything	115 (59.9)	106 (63.9)	9 (34.6)*
Add seasoning to fast-food	75 (39.1)	58 (34.9)	17 (65.4)
13. Ladle of rice in each meal			
1 ladle	57 (29.7)	46 (27.7)	11 (42.3)
2 ladles	99 (51.6)	89 (53.6)	10 (38.5)
3 ladles	30 (15.6)	26 (15.7)	4 (15.4)
4 ladles	5 (2.6)	4 (2.4)	1 (3.8)
14. Tablespoons of meat in each meal			
1 tablespoon	4 (2.1)	2 (1.2)	2 (7.7)
2 tablespoons	28 (14.6)	25 (15.1)	3 (11.5)
3 tablespoons	58 (30.2)	53 (31.9)	5 (19.2)
4 tablespoons	49 (25.5)	40 (24.1)	9 (34.6)
5 tablespoons	15 (7.8)	12 (7.2)	3 (11.5)
6 tablespoons or more	37 (19.3)	33 (19.9)	4 (15.4)
15. Ladles of vegetables per day			
0 ladle	8 (4.2)	6 (3.6)	2 (7.7)
1 ladle	49 (25.5)	45 (27.1)	4 (15.4)
2 ladle	67 (34.9)	59 (35.5)	8 (30.8)
3 ladle	43 (22.4)	38 (22.9)	5 (19.2)
4 ladle	18 (9.4)	12 (7.2)	6 (23.1)
5 ladle	6 (3.1)	5 (3.0)	1 (3.8)

Eating Habits/Consumption Behavior	Overall (192)	Bitter (166)	Not Bitter(26)
16. Servings of fruits per day			
0 serving	26 (13.5)	24 (14.5)	2 (7.7)
1 serving	84 (43.8)	71 (42.8)	13 (50.0)
2 servings	51 (26.6)	44 (26.5)	7 (26.9)
3 servings	22 (11.5)	20 (12.0)	2 (7.7)
4 servings	7 (3.6)	5 (3.0)	2 (7.7)
5 servings	1 (0.5)	1 (0.6)	0 (0)

Data were presented as n (%). Statistical differences between bitter tasters and non-tasters were determined using Chi square, Cramer's V or Mann-Whitney U Test depending on the variables, *p-value < .05.

Discussion

This study intended to find the percentage of bitter tasters in the young adult Thai population and the influence of bitter taste perception on daily food consumption patterns. In this study, 86.5% of the participants were bitter tasters, and 13.5% of the participants were found to be bitter non-tasters. This percentage of non-tasters was found to be lower than the Caucasian (30-40%) and Indian (>40%) (Levine & Anderson, 1932). However, it was similar to other Asian populations, such as Japanese (5-15%), Koreans (20%) (Hong et al., 2005; Sato et al., 1997), and Chinese (14%) (Wang et al., 2022). The results showed that genetic factors play a role in bitter taste sensitivity, as the percentage of bitter tasters was quite similar to that of the Asian population. Bitter tasters could not accept the bitter vegetables and were also picky eaters; on the other hand, bitter non-tasters preferred fatty foods and were prone to becoming obese (Keller & Adise, 2016). The association between bitter taste sensitivity and BMI was not consistent, and the findings are still controversial. In the Korean population, a higher BMI was found in bitter non-taster women, but there was no difference in BMI in men (Choi, 2019). In our study, data analysis showed no difference in BMI between bitter tasters and non-tasters.

The relationship between bitter taste sensitivity and fruit and vegetable intake was identified using different methods in different populations. In one research finding, the bitter non-tasters tended to consume more bitter cruciferous vegetables than bitter tasters (Calancie et al., 2018; Hald et al., 2021). The survey done in the USA population found no significant difference in fruit and vegetable intake between bitter tasters and non-tasters (Alardawi et al., 2020), and the same finding was seen in a meta-analysis (Bawajeeh et al., 2020). Similarly, our research found no significant difference in fruit and vegetable intake between bitter tasters and non-tasters. In addition, the consumption of rice and meat was not different between the two groups. The relationship between bitter taste sensitivity and other taste perceptions showed no significant difference between the two groups. Bitter taste sensitivity does not appear to be a direct factor influencing food consumption habits. Food intake and choice of food in people are influenced by many factors, like personal, cultural, environmental, social, and economic factors, and one or more of these factors may be considered in addition to taste or sensory stimulation (Mela, 1999; Neumark-Sztainer et al., 1999). Seasoning and sauce intake showed no difference in adding seasoning to rice or noodles between bitter tasters and non-tasters. Rice and noodles are the staple food for almost all Thai people, and there is a cultural habit of adding sugar, soy sauce, and chili sauce to these meals. However, a significant difference in consumption of seasoning with fast food was seen between the two groups: bitter non-tasters added more seasoning to the fast food, while bitter tasters added less seasoning. This may be due to the lower taste perception ability to all kinds of tastes in the bitter non-taster, which made them add more seasoning to make the food more delicious. It could be that the difference in the consumption of seasoning was influenced by cultural habits while eating with rice or noodles because of daily consumption, but it appeared with the consumption of fast food, which was eaten less frequently.

The strength of this study was that we could learn the influence of bitter taste sensitivity on the food consumption habits of young Thai adults as basic information and, at the same time, cultural and environmental influence. The limitation of this study is that it should consider additional factors, such as personal, cultural, environmental, social, and economic influences. One or more of these factors may play a significant role alongside taste or sensory stimulation. However, it could give the foundation and ideology for a new method in future research projects to find a solution for healthy eating habits and better lifestyle changes to prevent metabolic diseases.

Conclusions

Bitter taste sensitivity in the Thai young adult population is similar to that in other Asian such as the Japanese, Chinese, and Koreans. The difference in taste perception between bitter tasters and non-tasters can be influenced by various factors, including socio-economic, environmental and cultural factors. Therefore, in promoting lifestyle changes to prevent or reduce metabolic diseases in the future, it is important to consider all these factors in addition to taste sensitivity.

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