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Study on Taste Threshold in Subjects of University Students

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Abstract

The purpose of this study was to collect basic data on the sense of taste in young subjects in order to generate a quantifiable measure on which clinical examinations can be based. The test was performed on 31 university students between the ages of 18 and 22 (average age: 19.7 years). Each subjects filled out a questionnaire to determine their food qualitative preferences followed by quantitative taste examinations for the four basic tastes; sweet, salty, sour and bitter. We used filter paper disc method to evaluate the total mean of the cognitive thresholds of in both side of the chorda tympani and glossopharyngeal innervated regions of the tongue. We confirmed that the total mean values were within the normal range for both males and females, though two males showed mild abnormalities, and observed threshold distributions. These results of the data we gathered suggested that males might have a higher taste threshold than females in young subjects.

Key Words：taste preference, taste identification threshold, young subjects, sex difference

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Introduction

The number of people complaining of gustatory disorders is increasing by year. It is generally believed that the threshold of sense of taste increases with age, and this tendency increases as people get older[1]. On the other hand, due to changes in diet and lifestyle, the number of young age's individuals complaining of gustatory disorders has been also increasing in recent years[2]. However, there has been still lacked research regarding taste threshold in young adults. In addition, gustatory disorder (such as dysgeusia) is one of the symptoms of the SARS-Cov2 infection (COVID-19) that is currently prevalent worldwide[3]. In this study, we collected preliminary data on taste thresholds in young adult in order to provide contribution for clinical examination.

Materials and Methods

The study was conducted on thirty-one university students, 17 males and 14 females, aged between 18 and 22 (average age: 19.7 years) that show normal physical condition during the present taste examination. Informed consent was obrained by the documents beforehand. The subjects were filled out a questionnaire regarding their food preferences, qualitative and quantitative taste examination for sweet, salty, sour, and bitter tastes by the filter paper disc method using Taste Disc ® (Sanwa Kagaku Laboratory, Nagoya, Japan) was performed[12]. The focal region of the test was shown in Fig. 1 , which was determined to overlay the innervation regions of taste conducting nerves, chorda tympani and glossopharyngeal nerves and the taste examination parts of the tongue. The test was conducted starting with the lowest concentration, Reagent 1, and if it was not recognizable, the concentration was changed to the next higher concentration, Reagent 2. If it was still unrecognizable, the concentration was changed again to the next higher concentration, Reagent 3, and so on and so forth (Table 1.). The evaluation method was based on the total mean of the cognitive thresholds of sweet, salty, sour, and bitter tastes in the left and right chorda tympani and glossopharyngeal innervated regions. The subjects were not informed about the type of taste reagent before the taste examination was performed. The examination of four regions by four taste reagents was performed only once for each subject. The evaluation of the severity of

gustatory disorders (dysgeusia) by the filter paper disc method[12] was classified into the following five types (Table 2). "Normal" was that the total average value of all

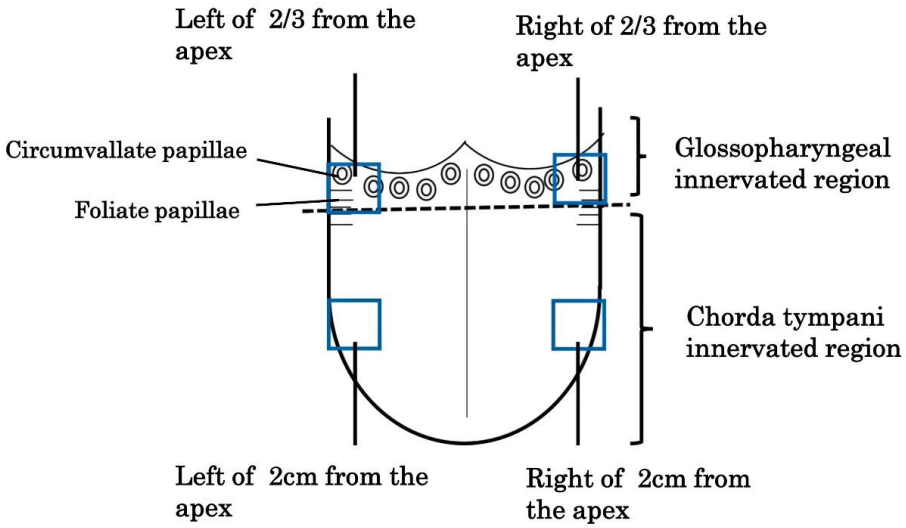

Fig. 1. The relationship between the innervation regions of taste conducting nerves, chorda tympani and glossopharyngeal nerves and the taste examination parts of the tongue

Reagent / Concentration	1	2	3	4	5
Sweetening solution S	15mg	125mg	500mg	1000mg	4000mg
Purified Sucrose	-0.30%	-2.50%	-10%	-20%	-80%
Salty liquid N	15mg	62.5mg	250mg	500mg	1000mg
Sodium chloride	-0.30%	-1.25%	-5%	-10%	-20%
Sour liquid T	1mg	10mg	100mg	200mg	400mg
Tartaric acid	-0.02%	-0.20%	-2%	-4%	-8%
Bitter liquid Q	0.05mg	1mg	5mg	25mg	200mg
Quinine hydrochloride	0.00%	-0.02%	-0.10%	-0.50%	-4%

Table 1. Taste test reagents and composition

Reagents was less than 3.0. "Boundary" was that total average value was greater than 3.0 and less than 3.5. "Mild" was that total mean value was between 3.5 and 4.5. "Moderate" was that total mean value was between 4.5 and 5.5. "Severe"

was that total mean value was 5.5 or more. No sensitivity was recognized in very few cases.

Table 2. Evaluation of the severity of gustatory disorders (dysgeusia) using the filter paper disc test

Type	Score	Description
Normal (Ⅰ)	1	The total average value is less than 3.0
Boundary (Ⅱ)	2	Total average value greater than 3.0 and less than 3.5
Mild (Ⅲ)	3	Total mean value between 3.5 and 4.5
Moderate (Ⅳ)	4	Total mean value is between 4.5 and 5.5.
Severe (Ⅴ)	5	Total mean value of 5.5 or more
No sensitivity (Ⅵ)	6	No response at the highest concentration

This work was approved by the ethical committees of Hokuriku University (H30-04). All subjects were given a detailed explanation of this study and provided written informed consent in accordance with the ethical guidelines of the ethical committee of Hokuriku University.

Results

Questionnaire Results

In regards to sweetness, 76.5% of males and 91.7% of females indicated that they liked it or liked it very much (Fig. 2). Similarly, 64.7% of males and 50.0% of females liked salty taste (Fig. 3), 76.5% of males and 66.7% of females liked sour taste (Fig. 4), and 23.5% of males and 25% of females liked bitter taste (Fig. 5).

The results of the questionnaire on taste showed that more than 50% of both male and female students liked or liked very much sweet, salty and sour tastes, while less than 25% liked bitter tastes. The percentage of males and females who liked or liked sweetness very much was 76.5% and 91.7%, respectively.

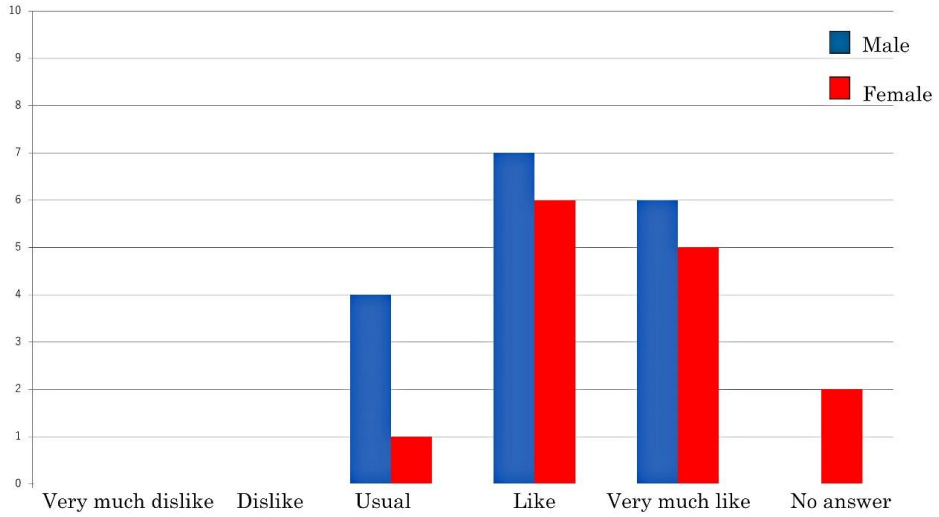

Fig. 2. Food preference for sweet (e.g., sweets, candy, juice) answered by questionnaire

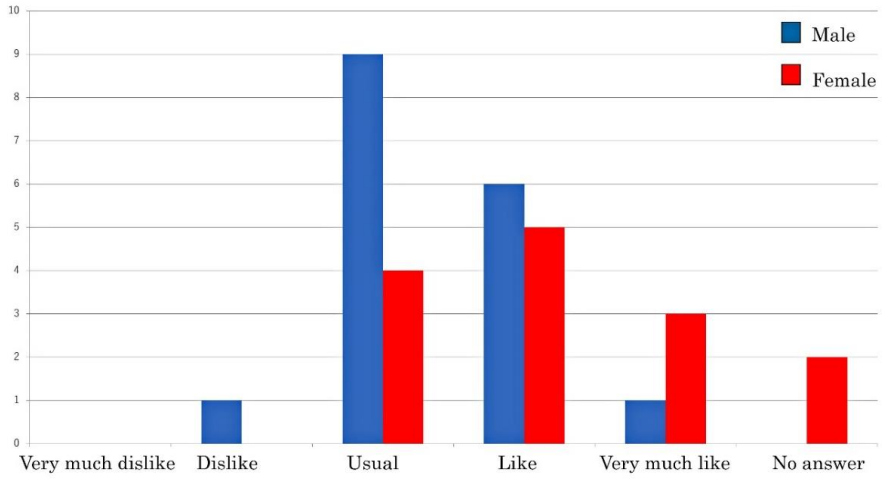

Fig. 3. Food preference for salt (e.g., pickles, salted fish) answered by questionnaire

Taste test results

All taste test results were divided into males and females and analyzed first in each sex. After then, we compared these data of both sexes to discuss the existence of sex differences of taste sense threshold in young subjects. At the same time, the data from four different regions were shown. This clarified the existence of regional

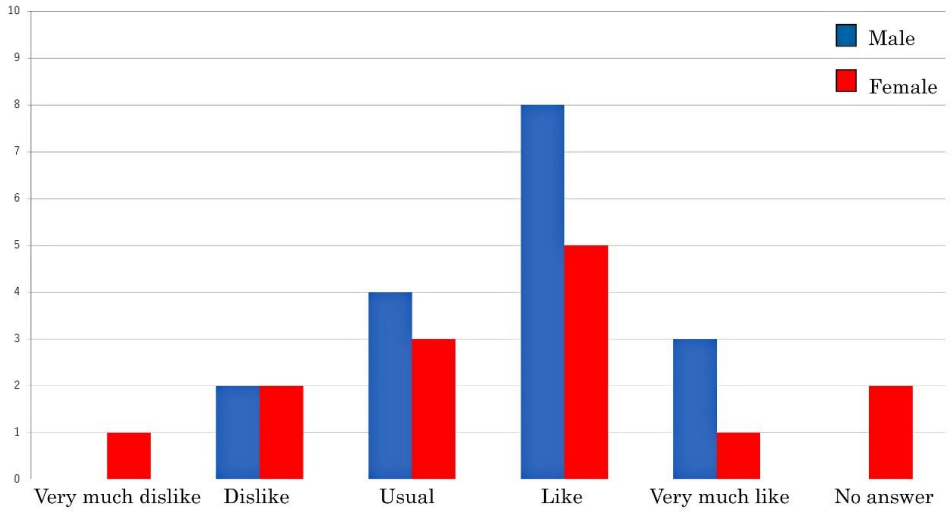

Fig. 4. Food preference for sour (e.g., citrus) answered by questionnaire

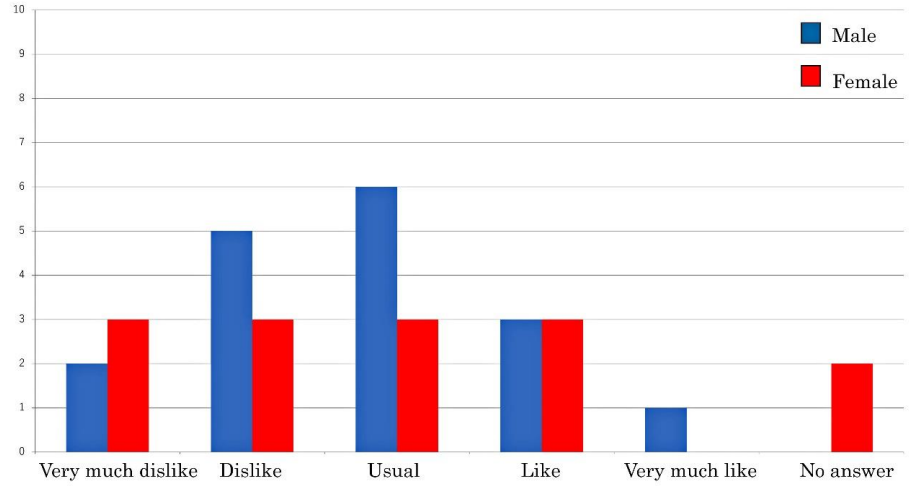

Fig. 5. Food preference for bitter (e.g., coffee) answered by questionnaire

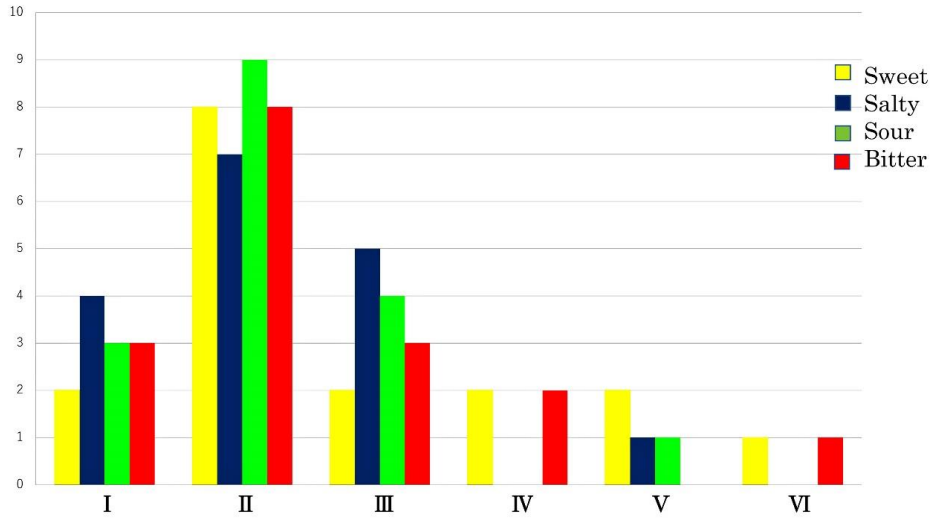

Fig. 6. Severity distribution for the basic four tastes in the left of 2 cm from the apex in males.

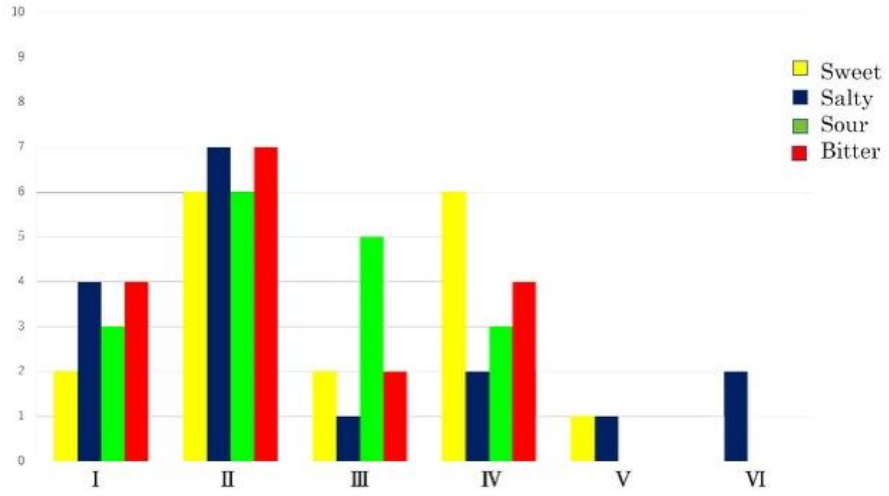

Fig. 7. Severity distribution for the basic four tastes in the right of 2 cm from the apex in males.

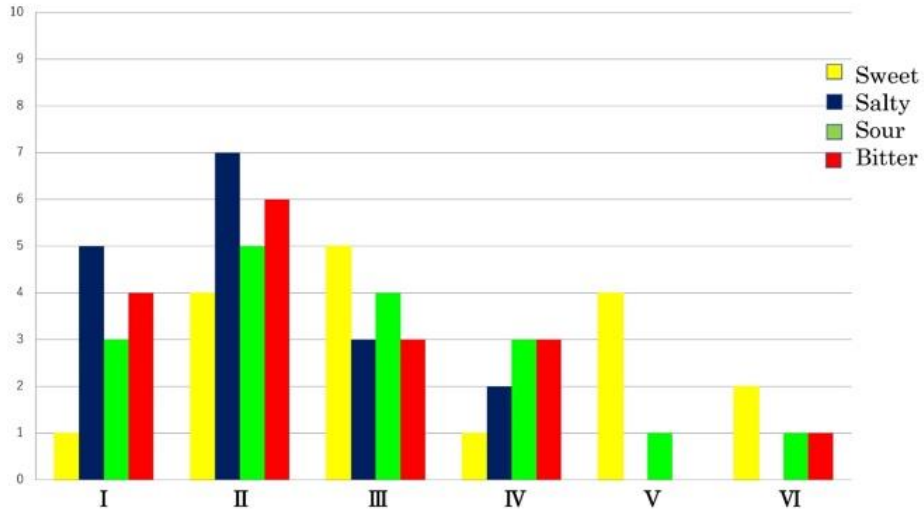

Fig. 8. Severity distribution for the basic four tastes in the left of 2/3 from the apex in males.

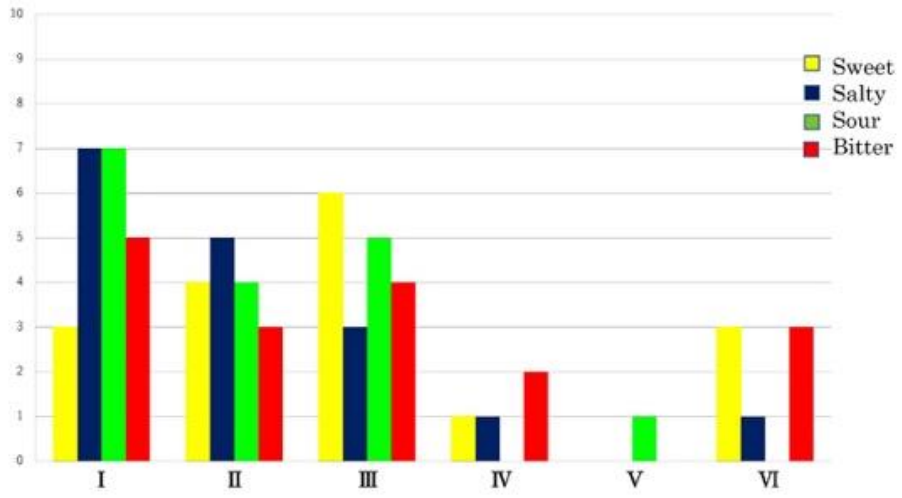

Fig. 9. Severity distribution for the basic four tastes in the right of 2/3 from the apex in males.

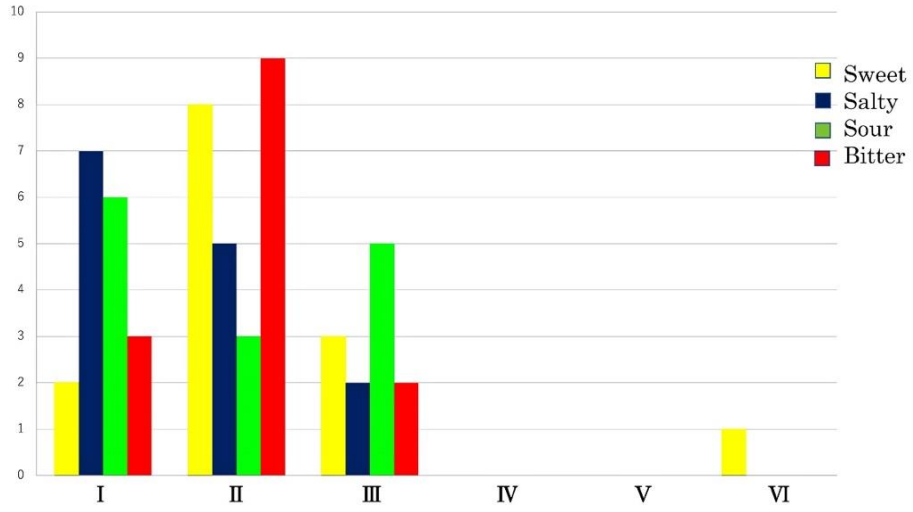

Fig. 10. Severity distribution for the basic four tastes in the left of 2 cm from the apex in females.

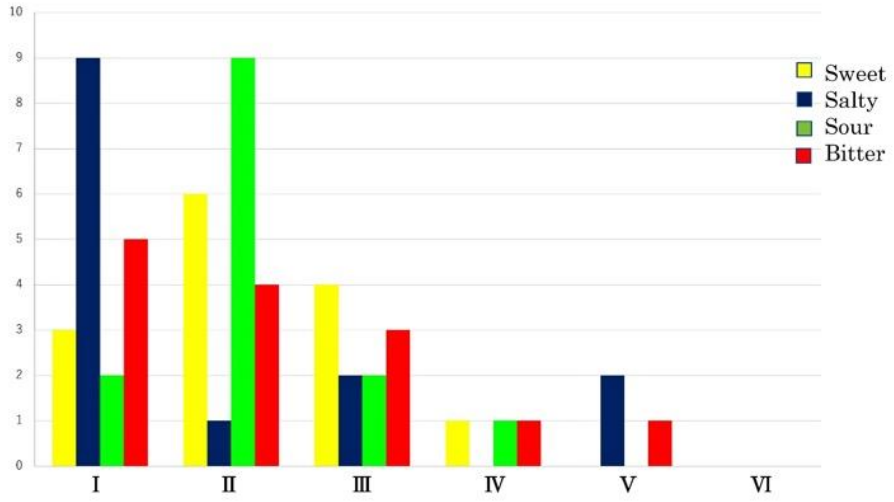

Fig. 11. Severity distribution for the basic four tastes in the right of 2 cm from the apex in females.

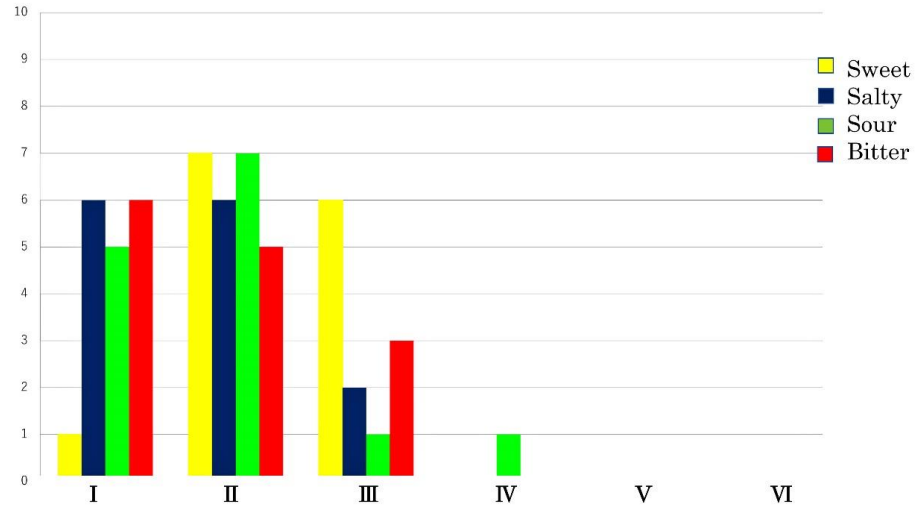

Fig. 12. Severity distribution for the basic four tastes in the left of 2/3 from the apex in females.

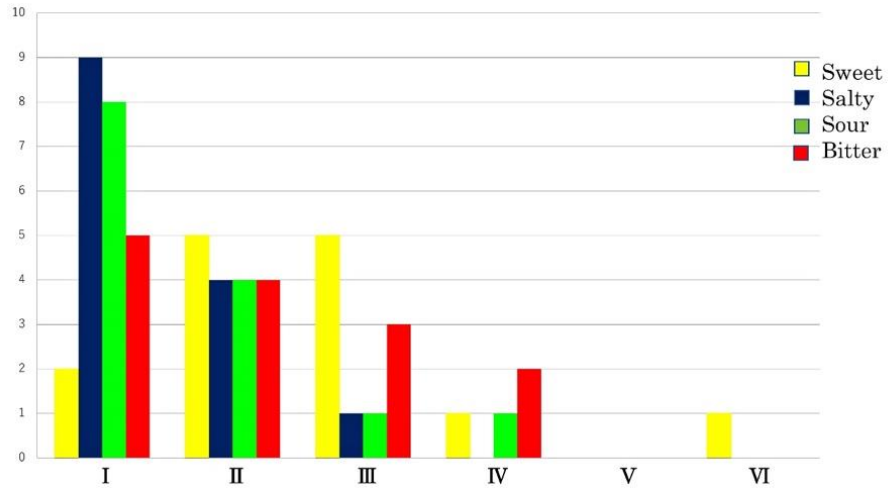

Fig. 13. Severity distribution for the basic four tastes in the right of 2/3 from the apex in females.

Table 3. The comparative mean scores of each of the tastes between the males and the females in the four different regions.

Reagent	Sex	Mean value of threshold score			
		Left region of 2cm from the apex	Right region of 2cm from the apex	Left region of 2/3 from the apex	Right region of 2/3 from the apex
Sweet	Male	2.82	2.88	3.53	3.00
	Female	2.36	2.21	2.36	2.64
Salty	Male	2.24	2.71	2.12	2.12
	Female	1.64	1.93	1.71	1.43
Sour	Male	2.24	2.47	2.82	2.06
	Female	1.93	2.14	1.86	1.64
Bitter	Male	2.47	2.35	2.53	2.88
	Female	1.93	2.21	1.79	2.14

Differences in the sense of taste, since there were two taste nerves, the chorda tympani and the glossopharyngeal nerve in the tongue (Fig. 1).

The results of the taste test of four regions in men are shown in Figures 6 to 13. Colored bar classified based on severity of gustatory disorders (I-Ⅵ) indicates number of subjects for each basic four tastes. Figure 6, 7, 10 and 11 shows data from 2 cm from the apex of the tongue, whereas Figure 8, 9, 12 and 13 shows data from 2/3 from the apex. The comparative mean scores of the cognitive threshold for each taste between males and female in four different regions were summarized in Table 3.

Discussion

It is believed that the relative threshold increases with age[1)]. The reason for this is thought to be that sensitivity to taste decreases with age[4)]. Although there have been many studies on taste, most of them are related to the elderly or systemic diseases[1, 4-6)], and there are few reports on young people in normal physical condition. In addition, taste can be impaired by systemic diseases, side effects of medications, psychosomatic factors, xerostomia, and other complex factors. Physiologically, taste disorders are thought to be caused by changes in taste receptors and transduction

pathways, but there is no unified view on this[5-7]. Although the pathogenesis of COVID-19, which is currently raging, is unknown, abnormal taste has been reported as one of the symptoms in both males and females of all ages[3]. As mentioned in the introduction, the number of complaints of dysgeusia in young people has been increasing in recent years, but there is little data on taste research. Therefore, we conducted a study on taste thresholds and collected data on preference among young adult individuals.

The results of the questionnaire on taste show that more than 50% of both male and female students like or like very much sweet, salty and sour tastes, while less than 25% like bitter tastes. It is thought that this is because animals are programmed from birth to instinctively prefer substances that can be used as a source of nutrition for survival, and humans should also have similarity[8]. In particular, sugar (e.g., glucose, sucrose, fructose, maltose, lactose), which is a source of energy, is essential, so sweetness is given top priority[9]. In this study, the percentage of males and females who like or like sweetness very much is 76.5% and 91.7%, respectively. On the other hand, bitterness is considered to be a taste that organisms do not like because it can be poisonous in nature (e.g. toxic alkaloid)[10]. In this study, 23.5% of males and 25% of females prefer bitter taste, which is lower than that of salty and sour tastes. Therefore, these results support the ideas of Gary[9] and Yarmolinsky[10].

There are various methods of testing for taste abnormalities, but in Japan, electric taste testing (electrogustometry) and filter paper disc testing are mainly used[11, 12]. Electrogustometry is a clinical application which, when electric current is applied to the tongue, gives a person the taste sensation of licking metal. The advantage of electrogustometry is that it provides excellent quantitative results for each neural region and the test takes less than 10 minutes to perform. The disadvantage of this method is that it is only a threshold test for the specific taste of metal, and cannot be used to identify sweet, salty, sour, bitter, and umami tastes. On the other hand, the filter paper disc method has the advantage of being able to qualitatively evaluate four of the five basic tastes (i.e., sweet, salty, sour, and bitter, but not umami) by dividing them into the left and right neural regions, and by concentration. The disadvantage of this method is that it requires repeated placement and removal of filter paper dipped in the taste solution on the tongue with tweezers, which is a complicated process and takes about 30 minutes to complete for

a person[12]. In this study, a detailed taste test is conducted using the taste disc method in order to compare it with a questionnaire on taste. The criteria for judging the severity of gustatory disorder are used. Sakai et al.[13] propose that a total average value of less than 3.5 is normal, between 3.5 and 4.5 is mild, between 4.5 and 5.5 is moderate, and greater than 5.5 is severe, and these criteria are still frequently used. In this study, it is used to establish criteria, although not for the purpose of diagnosis. As for differences between the sexes in taste perception, it has been reported that females generally have lower thresholds than males[14, 15]. According to Inokuchi et al.[16], the mean score of males is compared with that of females in the filter paper disc test, and although there is a difference between the two, it is not significant, and there is no need to differentiate between males and females in judging the severity of the disease. In this study, the total mean score is 2.58 in males and 2.00 in females, both within the normal range, but the threshold is higher in men. Furthermore, this study reveals that even in young subjects with no clear physical problems, different taste ranges can be found: normal, borderline, and mild.

We have been unable to find any reports of taste experiments conducted on adolescent adults with normal physical condition, and the fact that there is a significant difference in taste thresholds between males and females is a new finding that is expected to become basic data for future taste research. Although we would like to increase the number of subjects and further build up the data, it is difficult to conduct additional experiments due to the influence of COVID-19, so we have decided to present the results of our research to date. In addition, although the detailed pathway of COVID-19-induced gustatory disorder (dysgeusia) is unclear, it has been reported that it is more prevalent in females, and we hope to gain a full understanding of this issue.

In the present study, the correlation between the questionnaire results and taste threshold of each individual subject was not sufficiently analyzed. However, it would be an interesting problem to analyze the relationship between taste preferences and taste thresholds. Furthermore, it would be also important to determine whether there were sex differences in the above correlation analysis. In the near future, these issues should be examined from the same data used in this study.

Conclusion

We collected basic data on the sense of taste in youneg subjects and observed distributions in taste thresholds of across four examination parts between the sexes, which should prove useful in furthering research on taste in the future. Given the constraints due to COVID-19, we were unable to test enough subjects to gather sufficient data to generate a quantifiable measure on which clinical examinations can be based, so further research is necessary.

Acknowledgments

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