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TASTE SENSITIVITY CHANGES AMONG CONSUMERS OF PEMPEK-CUKO IN PALEMBANG CITY, SOUTH SUMATRA, INDONESIA

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ABSTRACT
Pempek is a typical food from Palembang, Indonesia. It is commonly consumed with *cuko*, a dipping sauce containing acetic acid which is corrosive. The research aimed to determine the absolute and recognition threshold, as well as changes in tongue sensitivity to sweet, salty and sour taste of the *pempek-cuko* consumers. The threshold measurements used the ASTM method. There were 78 panelists whom grouped based on the frequency of eating *pempek-cuko* per week, namely twice and more than twice per week. The results showed that the absolute threshold of panelists with the frequency of eating *pempek-cuko* twice per week for sweet, salty and sour tastes were 0.827%, 0.071%, and 0.041% respectively, while the recognition threshold were 1.241%, 0.107%, and 0.061% respectively. For panelists with a frequency of eating *pempek-cuko* more than twice per week, the absolute thresholds for sweet, salty and sour tastes were 1.581%, 0.243% and 0.066% respectively, while the recognition threshold were 2.371%, 0.365% and 0.099% respectively. The absolute and recognition threshold of all tastes for panelists whose frequency of eating *pempek-cuko* was more than twice per week was higher compared to panelists whose frequency of eating *pempek* and *cuko* was twice per week. Continuous exposure of the tongue to the sour taste with low acidity of *cuko* contributed to a decrease in tongue sensitivity to all of the tastes.

KEY WORDS
Pempek, *cuko*, absolute threshold, recognition threshold, taste.

Pempek is a typical food from Palembang city that has existed since the 7th century during the Sriwijaya Kingdom, originally known as *kelesan* (Surya et al., 2023). It is a staple food for the people of South Sumatra, especially Palembang, where it is commonly consumed for breakfast, lunch, dinner, and even as a snack throughout the day (Wargadalem, 2021). The basic ingredients of *pempek* are ground fish meat, tapioca flour, water, and salt. Additional ingredients may include eggs and seasonings (Supriadi et al., 2018). The mixture of these ingredients forms the base dough for various types of *pempek*, such as *adaan, lenjer, kulit, kapal selam, telor* and many more (Surya et al., 2023). *Pempek* is eaten with a thin sauce known as *cuko* (Wargadalem, 2021). The main ingredients of *cuko* are brown sugar, water, garlic, cayenne pepper, salt, seasoning, and an acidic agent that can come from tamarind, vinegar, lime, and kandis acid. *Cuko pempek* that is sold commercially generally uses vinegar which has the scientific name acetic acid. This vinegar is corrosive, so continuous consumption of *cuko pempek* containing acetic acid can damage tooth enamel (Muchsiri et al., 2020). If *cuko* can damage tooth enamel, it is also possible that it can damage the tongue, especially its taste sensitivity. This condition will worsen if, after consuming *cuko*, consumers do not immediately clean their mouth by rinsing because one way to prevent oral diseases is by rinsing with mouthwash to increase the pH of the mouth (Adzakiyah et al., 2015).

Taste sensitivity is the ability to respond to taste stimuli, which can be measured using methods such as detection threshold, recognition threshold, taste response, and fungiform papillae density (Ervina et al., 2020). Taste sensitivity on the tongue can influence taste perception. The perception of taste intensity can change if the tongue is continuously exposed to a particular taste with high or low intensity. This change can affect the palatability of certain foods. For example, a person who is accustomed to consuming salty foods will find

foods with very low salt content to be bland (Bolhuis et al., 2010). Suboptimal taste bud function can cause changes in taste perception and sensitivity, including saltiness. The taste threshold for salt increases due to decreased sensitivity to salt, which is the minimum concentration of salt that can be detected (Sari et al., 2022). The effect on taste sensitivity on the tongue is influenced by the intensity of the stimulus and the duration of exposure (Lasschuijt et al., 2021). Taste sensitivity and taste preference are correlated. If the sensitivity to salty, sweet, and umami tastes is higher, there will be a decrease in preference for those tastes (Chamoun et al., 2019).

The habit of Palembang residents to consume *pempek* with *cuko* may potentially affect their taste perception and tongue sensitivity to different taste modalities. Therefore, research is needed to investigate the extent to which this consumption affects their taste perception or tongue sensitivity to these modalities. Taste modality refers to the perception of taste on the tongue. Humans have five basic taste modalities: sweet, salty, sour, bitter, and umami (Puputti et al., 2019).

The human tongue, as an organ of taste, is equipped with thousands of taste buds (papillae) that appear as small bumps. In adults, the number of papillae ranges from 2,000 to 4,000. Papillae act as sensory cells that identify different tastes, including sweet, salty, sour, bitter, umami, and spicy. The taste buds on the papillae are responsible for identifying the taste of food. When we chew food, the taste buds stimulate nerve fibers called microvilli. Microvilli transmit messages to the brain, which interprets the type of taste detected (Budiarti, 2023). Taste receptor cells detect stimuli inside the mouth through the taste papillae buds. Taste signals are sent to the brain when receptor cells encounter taste molecules (Puputti et al., 2019). The number of taste buds decreases with age. The ability of the tongue to recognize taste declines at the age of 45, and taste loss becomes more significant in the late 50s (Walker, 2015).

The human tongue is capable of recognizing salty, sweet, sour, and bitter tastes with varying degrees of sensitivity to stimulus thresholds. The absolute threshold refers to the minimum level of sensory perception or the smallest amount of a stimulus that can evoke a taste sensation. The recognition threshold, on the other hand, is the level at which a taste can be identified as a specific type (Setyaningsih et al., 2010).

To understand the influence of *pempek* and *cuko* consumption on tongue sensitivity to taste modalities, a study involving *pempek* consumers in Palembang City is necessary. This research aims to determine the extent to which the tongue sensitivity of *pempek* and *cuko* consumers is affected by different taste modalities. The findings can serve as a guide for producers in developing food products that cater to the taste preferences of Palembang City residents. Producers can adjust the levels of sweetness, saltiness, and sourness in their products marketed in Palembang City and South Sumatra Province in general. Considering the aforementioned explanations, this study involves 78 panelists (Meilgaard et al., 2007) who meet the following criteria: Age below 45 years old (Walker, 2015); Non-smokers (Farhan et al., 2020; Yunus, 2020); Not pregnant (Basnawi, 2020).

Previous research on taste modalities has been conducted by: Baharuddin & Sharifudin (2015) on the inland and coastal communities of Sabah, Malaysia; Maulidiah & Fibrianto (2019) on employees of a MSG company; Hasanah et al. (2014) on the Minang, Javanese, and Nusa Tenggara ethnic groups; Yolanda et al. (2015) on the residents of West Java, Central Java, and East Java. However, none of these studies have examined the effect of continuous consumption of the same type of food over a long period of time on tongue sensitivity. Therefore, a study on *pempek* and *cuko* consumers and its influence on taste modalities is necessary.

METHODS OF RESEARCH

The research was conducted in the Laboratory of Chemistry, Processing, and Sensory of Agricultural Products, Department of Agricultural Technology, Faculty of Agriculture, Sriwijaya University, Palembang and Indralaya Campuses. The research was carried out from October 2023 to January 2024. The test materials used were: 1) *VIT* brand mineral

water; 2) *PSM* brand sugar with 100% sucrose content; 3) *Refina* brand table salt with 99.25% NaCl content; 4) Citric Acid brand citric acid with 100% $HOC(CH_2CO_2H)_2$ content. These materials were made into solutions as tastants, namely sugar solution, salt solution, and citric acid solution. The tools used were: 1) Clear plastic cups; 2) Stirrer; 3) Clear plastic spoons; 4) Plastic mineral water bottles; 5) Plain, colorless, and odorless tissue; 6) Questionnaires; 7) *AZ* brand pH meter model 86502 (China, 2023); 8) NDJ-85 *pendulum* viscometer model (China, 2021).

The threshold measurement was conducted using the ASTM (American Society for Testing and Material) method (Lawless & Heymann, 2010). The panelists were given test samples from left to right, starting from the tasteless one to the highest concentration. The panelists' assessment results were tabulated and then calculated for the absolute and recognition thresholds. The absolute threshold was obtained from the calculation of the minimum concentration that 50% of the panelists could detect (Ratnaningsih and Chayati, 2010; Gathcalian, 1989). This study used the linear regression equation calculation formula (Riadi, 2016; Walpole, 1993) as shown in equation (1).

$$Y_i = a + bX_i \qquad (1)$$

Where: Y_i = the percentage of panelists who detected the taste; X_i = the concentration of the tastant; a = the intercept of the regression line; b = the slope of the regression line.

To calculate the absolute threshold, the value of y in equation (1) is set to 50. For the recognition threshold, the value of y is set to 75 (Pratama, 2022). The percentage of people who reacted positively to the percentage of taste concentration was plotted in Microsoft Excel to obtain the linear equation and R-squared (R2). The R2 value explains how much of the variation or diversity of the dependent variable Y can be explained by the regressor X. In other words, it is the percentage of variability or diversity in the dependent variable that can be explained by the independent variable, with a value of $0 \leq R2 \leq 1$ (Koutsoyiannis, 1977; Sitepu & Sinaga, 2006).

The criteria for panelists in this study were as follows: 1) Age between 17-40 years old; 2) Have consumed *pempek* for at least one year and have a frequency of consuming *cuko pempek* twice a week; 3) Non-smoker; 4) Not pregnant; 5) In good health (not suffering from flu, cough, or fever). Panelists were selected based on the results of a form distributed to the Palembang community through social media. The prospective panelist form was created using Google Forms with the predetermined panelist criteria, and the link was distributed via WhatsApp. A total of 78 panelists met the criteria and their data was used for this study. The sensory test was conducted by inviting panelists to enter the test room in turns, with three to four panelists at a time.

Sugar solution was prepared by dissolving sugar (100% sucrose *PSM* brand) into mineral water according to the predetermined concentrations: 0%; 0.5% (b/v); 1% (b/v); 2% (b/v); 4% (b/v); 8% (b/v). Salt solution was prepared by dissolving salt (*Refina* brand 99.25% NaCl) into mineral water according to the predetermined concentrations: 0%; 0.04% (b/v); 0.08% (b/v); 0.16% (b/v); 0.32% (b/v); 0.64% (b/v). Acid solution was prepared by dissolving citric acid with 100% $HOC(CH_2CO_2H)_2$ content into mineral water according to the predetermined concentrations: 0%; 0.01% (b/v); 0.02% (b/v); 0.04% (b/v); 0.08% (b/v); 0.16% (b/v). All the prepared solutions were put into clear plastic cups, approximately 50 ml each, and given a different three-digit code. They were then placed on the test table for the panelists to taste, and refilled if the contents decreased.

The threshold analysis was conducted by asking the panelists to taste the provided samples, starting from the tasteless water solution (aquadest) to the highest concentration solution of each taste. Before moving on to the higher concentration solutions, the panelists were asked to rinse their mouths with mineral water to avoid contamination from the previous solution. The panelists then gave their assessment by writing down the number 1 (one) if they detected a taste, and the number 0 (zero) if they did not detect a taste in the sample. The panelists' responses were written on a questionnaire which was then tabulated for calculation and analysis according to the research objectives. This process was repeated

until all the sweet, salty, and sour solutions had been tasted. The data was then presented in a tabulated form to facilitate the calculation process and then plotted into a graph to obtain the linear regression equation.

The calculation of absolute and recognition thresholds was performed on the results of the panelists' test with a frequency of eating *pempek* and *cuko* more than twice a week and twice a week. The discussion was carried out by comparing the test results of the panelists with a frequency of eating *pempek* and *cuko* more than twice a week with those who ate twice a week.

RESULTS AND DISCUSSION

The panelists involved in this study consisted of 78 people with the criteria as shown in Table 1. The majority of the panelists were in the 17-20 years age group (39 people), followed by the 21-30 years age group (29 people). The number of taste buds on the human tongue up to the age of 20 years is 200 to 250 taste buds per circumvallate papilla. This number then decreases to 200 taste buds by the age of adulthood (Sunariani et al., 2007). Taste buds degenerate after the age of 45, resulting in decreased taste sensitivity (Guyton & Hall, 2011). Therefore, the panelists with the majority of young age groups (17-30 years) involved in this study (87%) will provide relatively accurate results.

Based on the duration of *pempek* consumption, 70 panelists (90%) had been eating *pempek* for more than three years. In terms of the frequency of *pempek* consumption per week, 52 panelists (67%) ate *pempek* more than twice a week, and 26 panelists (33%) ate *pempek* with *cuko* twice a week. This data indicates that the majority of the panelists involved in this test had been exposed to *cuko pempek* for a relatively long time, with a high frequency of *cuko pempek* consumption of ≥2 times per week.

Table 1 – Panelist Profile of Panelists in Research

No	Panelist Data	Percentage (%)
1	Male	26
2	Female	74
3	Age:	
	17-20	50
	21-30	37
	31-40	13
4	Duration of *pempek* consumption:	
	1-3 years	10
	More than 3 years	90
5	frequency of *pempek* consumption per week	
	2 times per week	33
	More than 2 times per week	67

This study also collected additional information from the panelists regarding their taste preferences and culinary habits. The questionnaire asked about their preferences for sweet, salty, sour, and spicy tastes, as well as their liking for pindang, a traditional Palembang dish with sour, salty, and spicy flavors that is a staple food for most Palembang residents. The survey aimed to determine the panelists' level of liking and frequency of pindang consumption, which can serve as supporting data for the taste sensitivity of pempek consumers who also consume pindang. Table 2 shows that 79% (62 people) of the panelists liked sweet tastes, 78% (61 people) liked salty tastes, 63% (49 people) liked sour tastes, and 83% (65 people) liked spicy tastes. Regarding their liking for pindang, 92% (72 people) liked pindang. The survey results also showed that 41% of the panelists consumed pindang three to four times a month, 17% consumed it five to eight times a month, and 6% consumed it more than eight times a month. This means that more than half of the panelists, or about 64%, consumed pindang more than three times a month.

An analysis of cuko acidity and viscosity was also conducted on several pempek producers in Palembang City. Based on a survey of 78 panelists, there were at least seven pempek producers that were the favorite customers of pempek, four branded producers with

relatively expensive prices, and three producers with relatively cheap prices. The results of the survey showed that the pH range of cuko that is often consumed by the people of Palembang is between 3.9 and 4.5 with a viscosity between 67.5 cPs and 84.5 cPs.

Table 2 – Preference for Taste and Cuisine

No	Types of tastes and cuisines	Like (%)
1	Sweet	79
2	Salty	78
3	Sour	63
4	Spicy	83
5	*Pindang*	92

In general, the absolute threshold is the smallest intensity value that can produce a sensation, while the recognition threshold is the minimum level of stimulus intensity required for a stimulus to be identified. In terms of taste, the absolute threshold indicates the lowest concentration of a type of taste that can be distinguished from its solvent, namely pure water, while the recognition threshold encompasses the lowest taste concentration that can be detected by the human sense of taste.

Taste threshold information is crucial in understanding consumer behavior. Producers can utilize such information to create packaging, branding, and advertising strategies that effectively capture consumer attention. Consequently, producers can make adjustments to product formulations to enhance consumer preference within a community. The recapitulation of absolute and recognition threshold values for sweet, salty, and sour sensations for panelists who consume *cuko pempek* twice a week and >2 times a week are presented in Tables 3 and 4.

Table 3 – Linear Regression Equation for Absolute Threshold

No.	Type of taste stimulus	Impression	Frequency of *cuko* consumption per week	The linear regression equation	R^2	Absolute threshold (%)
1	Sugar	Sweet	2	y = 60,44x	0,91	0,83
			>2	y = 31,63x	0,86	1,58
2	Salt	Salty	2	y = 700,55x	0,96	0,07
			>2	y = 205,42x	0,82	0,24
3	Citric acid	Sour	2	y = 1221,7x	0,99	0,04
			>2	y = 759,08x	0,90	0,07

The absolute and recognition threshold data for the sweet taste (Tables 3 and 4) shows that these threshold values are higher for panelists who consume cuko pempek more than twice a week. The absolute and recognition threshold values for the sweet taste for panelists who consume cuko pempek more than twice a week are almost twice as high as those for panelists who consume cuko pempek twice a week. This indicates that cuko pempek influences the increase in both absolute and recognition thresholds for the sweet taste.

Table 4 – Linear Regression Equation for Recognition Threshold

No.	Type of taste stimulus	Impression	Frequency of *cuko* consumption per week	The linear regression equation	R^2	Absolute threshold (%)
1	Sugar	Sweet	2	y = 60,44x	0,91	1,24
			>2	y = 31,63x	0,86	2,37
2	Salt	Salty	2	y = 700,55x	0,96	0,11
			>2	y = 205,42x	0,82	0,37
3	Citric acid	Sour	2	y = 1221,7x	0,99	0,06
			>2	y = 759,08x	0,90	0,10

Panelist members who eat *pempek* and its *cuko* more frequently have their tongues exposed to the sweet and sour tastes of the *cuko* more often and continuously over a long period of time. This causes their tongue's sensitivity to these tastes to decrease. This is in

line with previous research that suggests that the perception of taste intensity can change if the tongue is exposed to a certain taste with high intensity, and this change can affect the palatability of certain foods (Bolhuis et al., 2010). *Cuko pempek* generally uses acetic acid as its source of acidity, which is corrosive and can damage tooth enamel (Muchsiri et al., 2016). If *cuko* can cause damage to tooth enamel, it is likely that it can also be abrasive to the tongue. Continuous exposure to *cuko* can lead to a decrease in taste sensitivity. This condition can be worse if, after consuming *cuko*, consumers do not immediately clean their mouth by rinsing, because one way to prevent oral diseases is to rinse with mouthwash to increase the pH of the mouth (Adzakiyah et al., 2015).

The continuous habit of *pempek* consumers eating *cuko* and its sweet taste (*cuko* contains a lot of sugar) causes changes in taste sensitivity that can affect taste perception, and subsequently affect palatability. This is in line with what other researchers have stated, that the effect on taste sensitivity on the tongue is influenced by the intensity of the stimulus and the duration of exposure (Lasschuijt et al., 2021). This is also in accordance with the opinion of other researchers that sweet taste sensitivity is correlated with an increased liking for sweet foods (Ervina et al., 2020). Differences in sweet taste preference can be influenced by cultural differences (Hasanah et al., 2014). *Pempek* consumers have an increased sweet taste detection threshold, meaning their sweet taste sensitivity is decreased, resulting in an increased liking for sweet tastes. Other researchers have argued that environmental factors, namely diet and gene x environment interaction, can alter taste gene expression and the level of taste proteins/receptors produced (Archer et al., 2016).

Tables 3 and 4 show that the absolute and recognition thresholds for sour taste were higher in panelists who consumed *cuko pempek* more than twice a week. The absolute and recognition thresholds for sour taste for panelists who consumed *cuko pempek* more than twice a week were almost twice as high as those for panelists who consumed *cuko pempek* twice a week. The higher absolute and recognition thresholds for sour taste in panelists who ate *pempek* and its *cuko* more than twice a week may be due to the habit of *pempek* consumers eating *cuko pempek*, which is predominantly sour. The tongue's continuous exposure to the low pH acidic taste of *cuko* contributes to a decrease in tongue sensitivity. The results of a study on seven *pempek* producers that were frequently consumed by the panelists showed that the pH of *cuko pempek* ranged from 3.94 to 4.45. This means that *cuko pempek* has a fairly high acidity level. The habit of continuously eating sour *cuko* for a longer period of time in panelists who consume *pempek* more than twice a week causes changes in taste sensitivity that affect taste perception, and subsequently can affect its palatability more than in panelists who consume *pempek* twice a week. This causes changes in taste sensitivity in the panelists. The increased absolute and recognition thresholds for sour taste in these panelists also result in a decrease in their sour taste sensitivity.

This is in line with previous research suggesting that the tongue, when continuously exposed to a certain taste with high or low intensity, can change the perception of taste intensity and affect the palatability of certain foods (Bolhuis et al., 2010). This is also in accordance with the statement of other researchers that the intensity of the stimulus and the duration of exposure to a certain taste affect the taste sensitivity of the tongue (Lasschuijt et al., 2021). Diet can also affect taste sensitivity (Jeon et al., 2021). Taste disorders can occur, which are changes in taste function from normal to partial or total loss of taste or changes in the acuity of the sense of taste, one of which is caused by the consumption of certain foods. *Pempek* consumers who eat *pempek* and its *cuko* more than twice a week have a higher sour taste detection threshold, meaning their sour taste sensitivity is lower, resulting in an increased liking for sour tastes. This may be due to the *cuko* having a low pH.

Tables 3 and 4 show that the absolute and recognition thresholds for salty taste were higher in panelists who consumed *pempek cuko* more than twice a week. The absolute and recognition thresholds for salty taste for panelists who consumed *pempek* and its *cuko* more than twice a week were more than three times higher than those for panelists who consumed *pempek* and its *cuko* twice a week. The higher absolute and recognition thresholds for salty taste are due to the habit of *pempek* consumers eating *pempek*, which is predominantly salty. The habit of *pempek* consumers eating *pempek*, which is predominantly salty,

continuously over a long period of time causes changes in taste sensitivity that can affect taste perception, and subsequently can affect palatability and lead to changes in taste sensitivity in panelists. The increased absolute and recognition thresholds for salty taste in these panelists also cause their salty taste sensitivity to decrease. *Pempek* consumers have a higher salty taste detection threshold, meaning their salty taste sensitivity is lower, resulting in an increased liking for salty tastes.

This is in line with what previous researchers have stated, that someone who is used to eating salty foods will find food that is very low in salt to be bland (Bolhuis et al., 2010). When the ability to detect salty taste on the tongue decreases, it causes people to eat more salt. The salty taste threshold affects salt intake, mainly from taste, age, and satisfaction with the taste stimuli received. Suboptimal taste buds cause changes in perception and taste sensitivity, including salty taste. The salt taste threshold increases due to decreased sensitivity to salt, which is the minimum salt concentration that can be detected (Sari et al., 2022). The habit of consuming food with high salt content will increase the stimulus threshold for salty taste (Hasanah et al., 2014).

CONCLUSION

The absolute threshold values for panelists who consumed *pempek* and its *cuko* twice a week were 0.827% (sweet taste), 0.071% (salty taste), and 0.041% (sour taste). The recognition thresholds were 1.241% (sweet taste), 0.107% (salty taste), and 0.061% (sour taste). The absolute threshold values for panelists who consumed *pempek* and its *cuko* more than twice a week were 1.581% (sweet taste), 0.243% (salty taste), and 0.066% (sour taste). The recognition thresholds were 2.371% (sweet taste), 0.365% (salty taste), and 0.099% (sour taste). The higher absolute and recognition thresholds in panelists who consumed *pempek* and its *cuko* more than twice a week indicate that *cuko pempek* can reduce the sensitivity of the taste buds to sweet, salty, and sour tastes.

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