

RESEARCH STUDY

English Version

OPEN ACCESS

Correlation between Sensory Attributes and Emotional Sensory Mapping in Fermented Pineapple (*Ananas comosus* L.) Peels Beverage

Korelasi Atribut Sensori dan Emotional Sensory Mapping Produk Minuman Fermentasi Kulit Buah Nanas (*Ananas comosus* L.)

Caca Pratiwi^{1*}, Iza Ayu Saufani¹, Latifah Rahman Nurfaziah¹¹Nutrition Study Program, Faculty of Engineering, Universitas Negeri Medan, Medan Estate, Indonesia**ARTICLE INFO**

Received: 26-09-2025

Accepted: 31-12-2025

Published online: 31-12-2025

***Correspondent:**

Caca Pratiwi

cacapratiwi@unimed.ac.id

10.20473/amnt.v9i1SP.2025.242-250

Available online at:<https://e-journal.unair.ac.id/AMNT>**Keywords:**

Fermentation, Tepache, Sensory, CATA, Emotional Sensory Mapping

ABSTRACT

Background: The commercial development of tepache beverages requires systematic mapping of sensory attributes, such as the Check-All-That-Apply (CATA) method, to ensure alignment with consumer perceptions. However, integration of emotional responses during sensory evaluation remains relatively underexplored. Emotional profiling offers complementary insights alongside conventional sensory acceptance data, offering a more holistic understanding of consumer responses to the product.

Objectives: This study aimed to identify the sensory profile of tepache beverages using the CATA method and to determine emotional profiling through the Emotional Sensory Mapping (ESM).

Methods: This study was conducted in two stages: Sample preparation and sensory testing. The materials used included three formulations of tepache beverage (A, B, C), mineral water, and crackers. The tools utilized were stationery, questionnaires, cups, and the XLSTAT 2020 software.

Results: Correspondence Analysis showed that product A is closely correlated with acidity, product code B with citrate, and product code C with sparkle. Emotional profiling in Cochran's Q test revealed significant difference at 5% level, with relaxing, energy, plain, and satisfied influencing consumer perceptions.

Conclusions The correlation between the mouthfeel sensory attributes and preference for the tepache beverage samples was found in sweetness and richness, while the sensory attributes at swallow were lightness and richness. Emotional profile mapping indicates that consumers prefer relaxing emotional response observed in product C.

INTRODUCTION

Fermented beverage industries have been developing rapidly to improve food product sustainability, mainly by utilizing the agroindustrial wastes. For example, *tepache*, a traditional beverage from Mexico, has been gaining more attention among the community. *Tepache* is made from fermented pineapple (*Ananas comosus* L.) peels added with sugar and spices, which produces sweet, sour, and slightly-carbonated tastes¹. Besides producing special tastes, this product is highly beneficial for health due to its probiotic contents². This beverage is highly popular in its origin country and has been gaining its popularity abroad, as in European and Asian countries, which triggers its development as a big-scaled commercial product³. In Indonesia, *tepache* is beginning to gain recognition. Previously, a hedonic test was conducted to evaluate the preference among Indonesian panelists toward *tepache*, which showed that the average acceptance of panelists across the sensory attributes

(color, aroma, taste, and texture) of *tepache* is "slightly liked" to "highly liked"⁴. Product development in a new region requires an organoleptic quality assessment to ensure alignment with local consumer preferences. Sensory analysis serves as a methodological approach to obtain comprehensive information on the quality characteristics of food product⁵.

The commercial development of *tepache* beverages presents challenges to ensure acceptable product characteristics for consumers. Mapping the sensory attributes of tepache represents an essential initial step to align the product with market preferences. Sensory attribute mapping serves as a foundation for introducing a product into a new region by identifying the most favorable attributes by prospective consumers. Reliance solely on hedonic testing cannot provide comprehensive information regarding the specific characteristics preferred by consumers⁶. Therefore, a further evaluation is conducted using the Check-All-That-

Apply (CATA) method to determine attributes that accurately reflect consumer perceptions. The CATA method offers a practical way, when trained panelists are difficult to access. In this method, panelists respond to structured questions with descriptive phrases, which they can select to characterize the product⁷.

Tasting a food product can surely create consumers' emotions, such as refreshing, relaxing, motivating, etc. Thus, information on emotion's attributes during consuming the product is high essential, due to providing data related to interaction between the product and consumers⁸. Sensory attributes are known to present a correlation of emotions, when consumers consume a product⁹. The emergence of emotions when consuming a product offers required data related to what attributes indicate a positive emotion or a negative emotion that reduces the product's likeness. An emotional sensory mapping (ESM) test demonstrates types of emotions that correlate with sensory attributes.

Mapping and correlating emotional responses during sensory evaluation are rarely explored. Emotional profiling can provide complementary data beyond conventional sensory acceptance, offering deeper insights into consumer perception. The emotions emerged during product evaluation may significantly influence consumer purchasing decisions, with both positive and negative emotional responses potentially enhancing or diminishing the product value¹⁰. In addition, the integration of sensory evaluation and emotional profiling in fermented pineapple peel beverages

(*tepache*) have' not yet been comprehensively investigated, despite the growing interest in functional beverage consumption. This study was conducted to identify and characterize the sensory profile of *tepache* using a relatively novel sensory analysis method, Check-All-That-Apply (CATA). In addition, emotional profiling was examined through the Emotional Sensory Mapping (ESM) method.

METHODS

Procedures

This study employed an experimental method divided in two steps: (1) *Tepache* beverage samples production; (2) *Tepache* sample tests with CATA method for sensoric and emotional profiling. The study's flowchart is presented in Figure 1. Materials used for producing fermented pineapple peel beverages (*tepache*) were divided in three formulas: A = 500 g pineapple peels + 500 g brown sugar; B = 500 g pineapple peels + 600 g brown sugar; C = 500 g pineapple peels + 700 g brown sugar. Other materials were mineral water and crackers. Meanwhile, equipment used for sensoric test was composed of writing tools, label paper, questionnaires, sample dish, and XLSTAT 2020, as a statistical analysis software integrated with *Microsoft Excel* to provide further statistical analyses, like sensoric data, regression, and ANOVA. The formulation were projected on brown sugar's composition as a substrate for lactic acid bacteria (LAB)'s growth during fermentation¹¹.

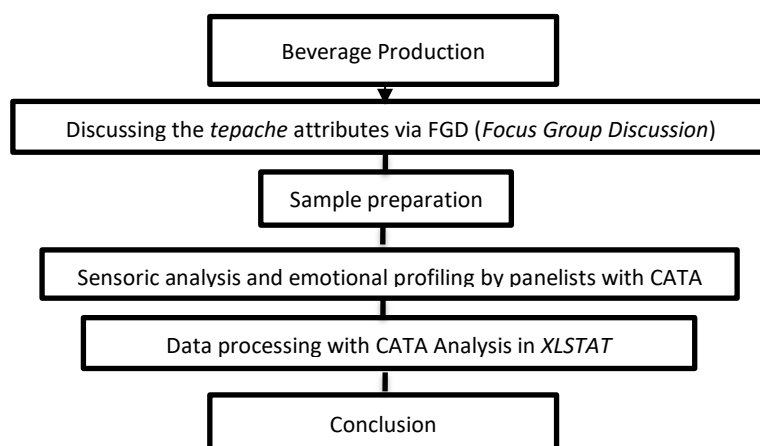


Figure 1. Sensory attributes and ESM Procedural Flowchart on *Tepache*

Beverage Production

All product samples were produced following the formulations applied. *Tepache* beverages were produced through four stages: (1) Preparing sugar solution by dissolving brown sugar in a boiling water (100°C), then stood for a while until the brown sugar solution was at room temperature; (2) Preparing pineapple peels by separating the peels from the fruit flesh. Peels were

washed and removed from dirt until clean; (3) Mixing the brown sugar solution and pineapple peels following the formulas applied. This mixture was fermented for 48 hours; (4) After fermentation, *tepache* was ready to consume by withdrawing the pineapple peels and filtering the *tepache*. All equipment, materials, and procedures for producing the beverages are presented in Figure 2 and 3.



Figure 2. Equipment (bowls, glass container, dishes) and materials (brown sugar, pineapple peels, water) for fermented pineapple peels beverage (*tepache*) production following each formula



(a) Boiling the brown sugar in a water; (b) Pouring the brown sugar solution on a glass container; (c) Mixing the pineapple peels with brown sugar solution; (d) Fermentation process in 48 hours (e); Beverage filtration

Figure 3. Beverage Production Procedure

Focus Group Discussion (FGD)

In this study, FGD was subjected to determine the sensory attributes presented in *Tepache* beverages and emotional attributes emerged when consuming the

product. FGD was performed by involving four panelists. Selected attributes from FGD (Tables 2 and 3) were then used for CATA test.

Table 2. Sensory attributes

Attributes	Descriptions
Sweet	Flavor associated with basic taste of palm sugar
Peely	Flavor associated with pineapple peel
Sour	Flavor associated with acidity
Sparkle	Flavor associated with a soda-like effect
Fresh	Flavor associated with freshness
Citric	Flavor associated with pineapple
Bitter	Aftertaste leaving a bitter note
Light	A light impression during consumption
Rich	A thick/full impression
Astringent	Aftertaste leaving an astringent note

Table 3. Emotional attributes

Emotions	Descriptions
Refreshing	A refreshing impression
Relaxing	A relaxing impression
Energizing	An energizing impression
Warming	A warming impression
Comforting	A pleasant impression
Exciting	A feeling of interest
Plain	A neutral feeling
Unique	A unique impression
Pleasure	An enjoyment impression
Satisfying	A feeling of satisfaction

Sample Assessment Preparation

A 20-ml sample was poured on a 50-ml transparent plastic glass. At cold temperature, the beverage was served at 5-15°C. A 240-mL of mineral water and crackers were available to neutralize panelists' sensory after tasting each sample. Crackers were provided to remove the aftertaste to help panelists

assess more accurately on sensory characteristics of each sample. Crackers could wash mouth area from aftertaste, without affecting panelists' assessment when tasting each sample ¹².

Sensory Analysis and Emotional Profiling

The attributes obtained from the FGD were subsequently tested on 50 untrained panelists, involving the Nutrition students from Universitas Negeri Medan at 19–22 years old. The panelists were undertrained students who had previously consumed *Tepache*, with a minimum number of 30 students¹³. Prospective panelists completed informed consent forms as an expression of their willingness to participate in the testing procedures of this study. Ethical approval for the use of human subjects was approved on August 28, 2024, by the Health Research Ethics Committee of Universitas Kristen Maranatha (Approval No. 132/KEP/VIII/2024). Inclusion criteria required panelists that were familiar with and have consumed *tepache*, while exclusion criteria applied to those who never consumed or had been exposed to *tepache*. Each panelist received one set of samples for each formula (5 mL), a 240-mL mineral water, and crackers to neutralize the mouth after tasting. Panelists were instructed to hold the sample in the mouth while following the timing cues provided by the facilitator. Upon the command “start,” panelists began to assess the product by holding the sample in the mouth for 15 seconds, as instructed. Sensory attributes obtained at the specified time were recorded, after the sample was swallowed and further identification continued from the

16-th to the 20-th second. Sensory evaluation in this study employed the Check-All-That-Apply (CATA) method to assess consumer preferences regarding the sensory and emotional characteristics of *tepache*, besides identifying the relationship between sensory profiles and their impact on product enjoyment. The CATA data were subsequently processed using *XLSTAT 2020* software.

Data Analysis

The sensory test results were analyzed using *CATA analysis tools* in *XLSTAT*. The sensory assessment with CATA method was obtained from the analysis results of Cochran’s Q test within each sample in 5% significant level, revealing the *p-value* which showed a significant difference among product samples on each sensory attributes¹⁴.

RESULTS AND DISCUSSIONS

Tepache Beverage Product

The *tepache* beverages were processed through fermentation for 48 hours. The products’ appearance in various formulas is shown in Figure 4. These products were tested their sensory attributes by selected panelists.



Figure 4. *Tepache* beverages made from various formulas. Note: A = 500 g pineapple peels + 500 g brown sugar; B = 500 g pineapple peels + 600 g brown sugar; C = 500 g pineapple peels + 700 g brown sugar

Perception Mapping on *Tepache* Beverages

The three *tepache* beverage samples, namely product A, B, and C, were evaluated by 50 panelists. The sensory attributes determined from the focus group discussion (FGD) were composed of sweetness, peely, sour, sparkle, fresh, citrus, bitter, light, rich, and astringent. The samples were tested using the Check-All-That-Apply (CATA) method to determine correlations between sensory and emotional attributes, product samples, and preferences for *tepache*. In the CATA, panelists were asked to perform two rounds of attribute identification: (1) When the sample was in the mouth; and (2) After being swallowed. This two-stage evaluation was essential, because untrained panelists often found

difficulties in providing accurate assessments with a single sip¹⁵. Panelists were required to identify all sensory characteristics during assessment, allowing the method to describe a detailed condition of product sensory attributes over time, including before-, during, and after-taste profiles. The CATA data were analyzed using the Cochran’s Q test with Multiple Pairwise Comparisons (McNemar). This test compared each sensory attribute across the three samples at 5% significance level, obtaining *p-values* that indicate significant differences among products for each attribute. As presented in Table 3, significant differences for the attributes of sweet, sour, bitter, and rich at the 5% level were observed when the samples were evaluated in the mouth¹⁶.

Table 3. Cochran’s Q test of *tepache* in the mouth at 5% level

Attributes	p-value	Sample Codes		
		A	B	C
Sweet	<0.0001	0.040 (a)	0.540 (b)	0.860 (c)
Peely	0.303	0.720 (a)	0.580 (a)	0.660 (a)
Sour	0.000	0.580 (b)	0.280 (a)	0.200 (a)
Sparkle	0.105	0.280 (a)	0.220 (a)	0.420 (a)
Fresh	0.497	0.920 (a)	0.960 (a)	0.900 (a)

Attributes	p-value	Sample Codes		
		A	B	C
Citric	0.390	0.840 (a)	0.920 (a)	0.840 (a)
Bitter	<0.0001	0.040 (a)	0.420 (b)	0.740 (c)
Light	0.526	0.920 (a)	0.920 (a)	0.860 (a)
Rich	<0.0001	0.180 (a)	0.260 (a)	0.820 (b)
Astringent	0.957	0.520 (a)	0.500 (a)	0.520 (a)

Values on the same line followed by the same letters indicate a significant difference at 5% level.

When the samples were swallowed, the sensory attributes of each product were insignificantly different at the 5% level, except for the attributes of peely, sour, sparkle, and fresh (Table 4). This condition indicates that differences occur in the sensory characteristics when present in the mouth and after being swallowed. Based on the Cochran's Q test results, sparkle attribute increased in products A and B. The sparkle characteristic of these products produced a stronger soda-like sensation upon swallowing. Carbon dioxide was generated during *tepache* fermentation, creating a distinct soda sensation as bubbles burst in the mouth, which intensified when swallowed. This sensation enhances gustatory responses by providing a sharp

stimulus that functions as a sensory signal of freshness and may escalate preference in the beverage¹⁷. Panelists' evaluations generally showed a decline between the in-mouth and post-swallow phases. Sensory perceptions tend to be more pronounced when stimuli directly interact with taste receptors. The freshness attribute was observed to decrease, due to associated with the presence of aroma compounds. In *tepache*, compounds produced from the fermentation of palm sugar and sugars in pineapple peels produced alcohols and acids that contributed to sweet, sour, refreshing sensation in the mouth, then degraded as the sample reached the throat¹⁸.

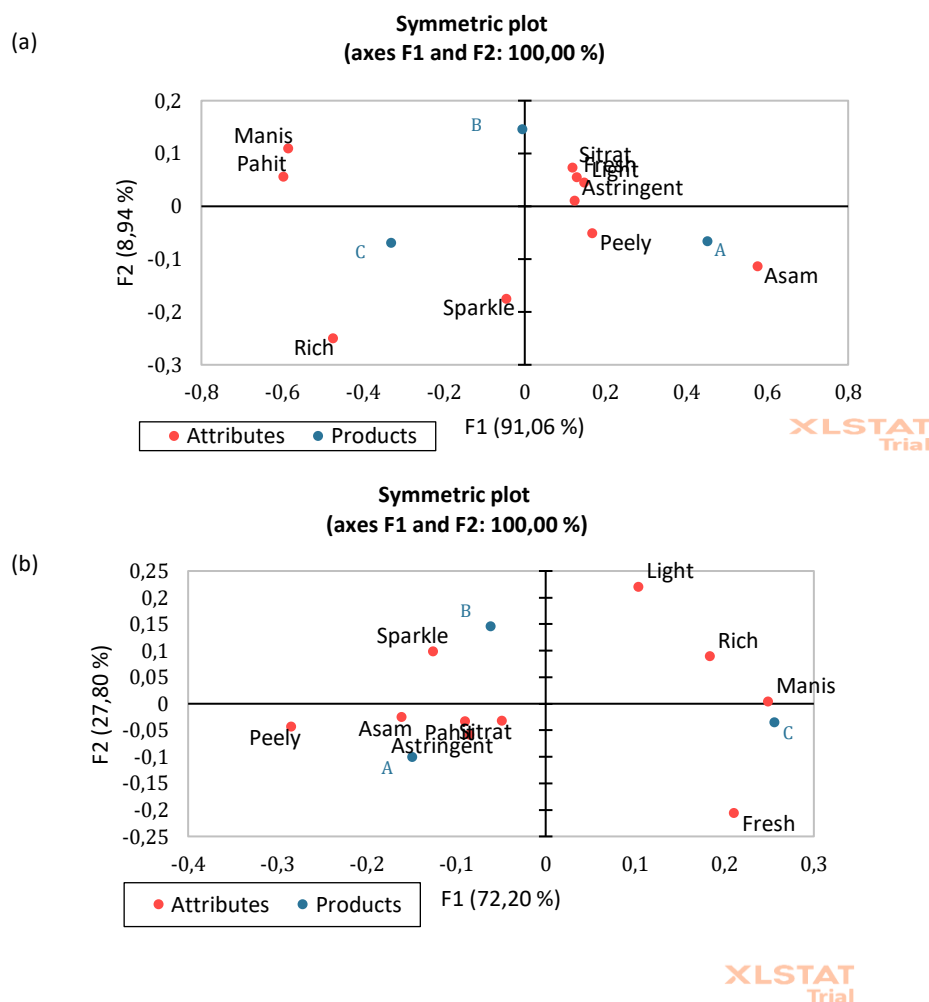
Table 4. Cochran's Q Test on Swallowed *Tepache* at 5% level

Attributes	p-value	Sample Code		
		A	B	C
Sweet	0.102	0.400 (a)	0.420 (a)	0.560 (a)
Peely	0.001	0.500 (b)	0.360 (ab)	0.180 (a)
Sour	0.053	0.460 (b)	0.360 (ab)	0.240 (a)
Sparkle	0.004	0.560 (b)	0.580 (b)	0.340 (a)
Fresh	0.001	0.460 (b)	0.260 (a)	0.500 (b)
Citric	0.174	0.520 (a)	0.420 (a)	0.360 (a)
Bitter	0.131	0.480 (a)	0.380 (a)	0.300 (a)
Light	0.130	0.260 (a)	0.420 (a)	0.320 (a)
Rich	0.539	0.320 (a)	0.400 (a)	0.420 (a)
Astringent	0.105	0.480 (a)	0.360 (a)	0.300 (a)

Values on the same line followed by the same letters indicate a significant difference at 5% level.

The results of the correspondence analysis produced a biplot map representing the product profiles¹⁹. The biplot illustrates the correlations between samples and the sensory attributes (Figure 5). Based on the correspondence analysis, the sensory profile correlations of *tepache* during the in-mouth phase

(Figure 5a) reveals that product A is closely associated with sour, product B with citric, and product C with sparkle. The correlations between attributes and *tepache* during the post-swallow phase are shown in Figure 5b. Similar to the in-mouth phase, sour was closely correlated with product A, while product B with sparkle and product C with sweet.



The CATA analysis was constructed in a Principal Coordinate Analysis (PCoA), illustrating the correlation between sensory attributes and panelists' preference for each *tepache* formulation. Based on the PCoA results (Figure 6a), the sensory attributes of *tepache* during the in-mouth phase positively correlated with sweet and rich. In contrast, during the post-swallow phase (Figure 6b), the attributes that correlated positively were observed in light and rich. Sweet flavor in *tepache* was originated from brown sugar and natural sugars in pineapple peels. Pineapple peels contain fructose and glucose, which contribute to the sweet flavor of *tepache*²⁰. In addition, only several parts of the sugar were converted into acids,

sustaining the sweet flavor in the beverage during fermentation, categorized as a main characteristic of *tepache*. The light attribute preferred by panelists was associated with the addition of sugar and spices, which enhanced a lighter mouthfeel perception. By adjusting the type and amount of sugar, sweet flavor can be balanced, without dominating sour flavor produced during fermentation, thereby creating a flavor equilibrium highly desired by consumers²¹. The rich attribute was derived from additional ingredients such as spices in *tepache* production, contributing to the overall complexity and flavor depth²².

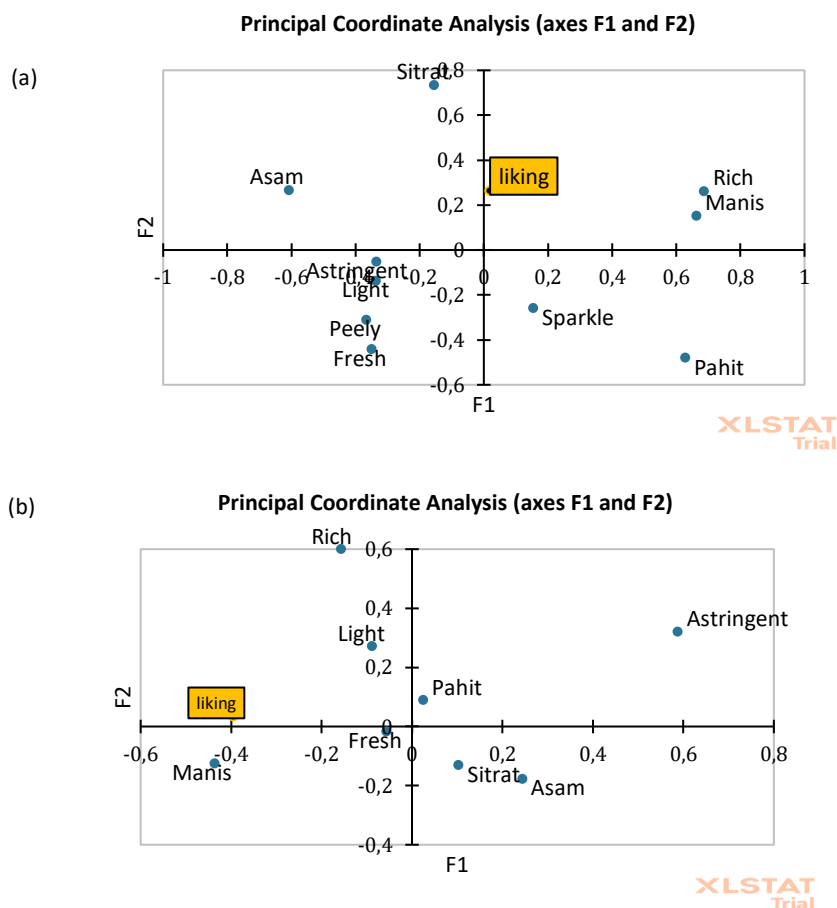


Figure 6. Correlation of sensory attributes and perception of *tepache*: (a) When present in the mouth; (b) Being swallowed

Emotional Profiling on *Tepache*

Sensory evaluation using the Check-All-That-ApPLY (CATA) method was also employed to assess the emotional profile of *tepache* beverages based on panelists' preferences. The attributes were determined from the focus group discussion (FGD), namely refreshing, relaxing, warming, energizing, comforting, exciting, plain, unique, pleasure, and satisfying.

Emotional profiling was conducted to describe consumer perceptions within the sensory characteristics of *tepache*. The Cochran's Q test results on the emotional profiles of *tepache* are presented in Table 5. The relaxing, energizing, plain, and satisfying showed significant differences among the products at the 5% significance level.

Table 5. Cochran's Q Test on emotional attributes at 5% significance level

Attributes	p-value	Sample Codes		
		A	B	C
Refreshing	0.130	0.220 (a)	0.220 (a)	0.360 (a)
Relaxing	<0.0001	0.280 (a)	0.320 (a)	0.640 (b)
Energizing	0.004	0.220 (a)	0.460 (b)	0.480 (b)
Warming	0.439	0.380 (a)	0.260 (a)	0.340 (a)
Comforting	0.597	0.420 (a)	0.420 (a)	0.340 (a)
Exciting	0.819	0.320 (a)	0.340 (a)	0.300 (a)
Plain	0.001	0.100 (a)	0.100 (a)	0.360 (b)
Unique	0.311	0.280 (a)	0.400 (a)	0.360 (a)
Pleasure	0.756	0.440 (a)	0.500 (a)	0.460 (a)
Satisfying	0.010	0.140 (ab)	0.100 (a)	0.340 (b)

Values on the same line followed by the same letters indicate a significant difference at 5% level.

Based on the correlation mapping of *tepache* products with emotional attributes (Figure 7), product A

was closely associated with the warming emotional attribute, product B with unique, and product C with

relaxing. Figure 8 illustrates the mapping of consumer perception related to emotional profiles. Consumers prefer tepache as a relaxing beverage, as this attribute was located in the same area as the perception point. A strong correlation between perception and relaxing

attribute was found in product C. Emotional profiling can be utilized in product introduction strategies, as consumers' emotional responses represent a critical approach for evaluating consumer acceptance on a beverage product²³.

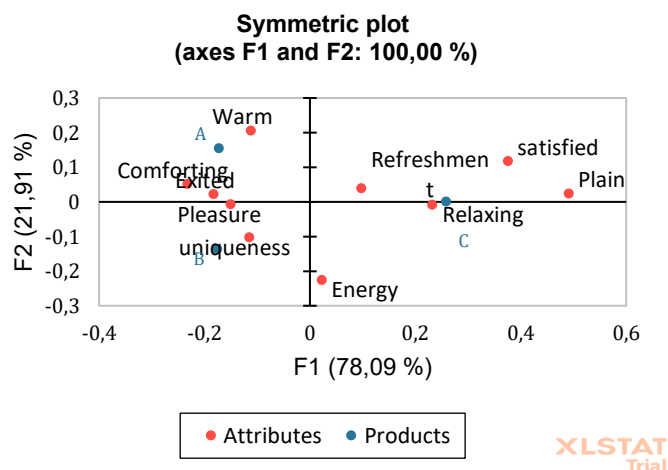


Figure 7. Correlation of *tepache* and emotional attributes

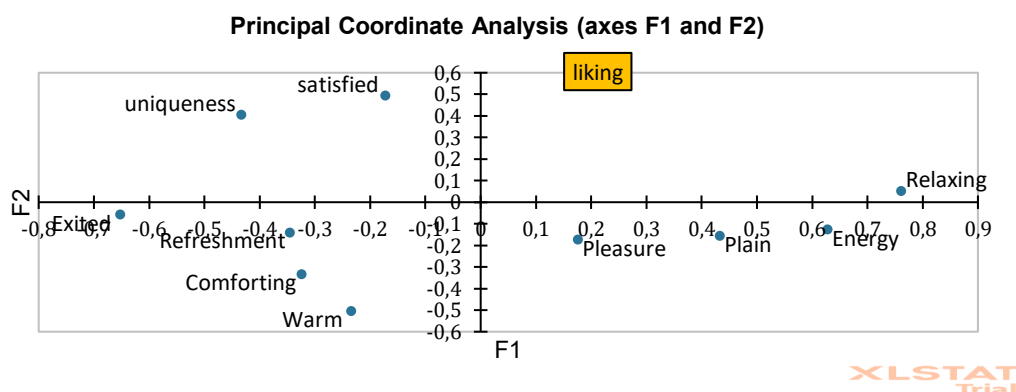


Figure 8. Correlation of emotional attributes and perception on *tepache*

CONCLUSIONS

A consistent correlation in sensory attribute of *tepache*, namely sour, between the in-mouth and post-swallow phases was found in product A. In contrast, products B and C exhibited differing correlations between both phases. The sensory attributes correlated with perception during the in-mouth phase were sweet and rich, while in the post-swallow phase were light and rich. Emotional profile mapping indicates that consumers prefer *tepache* as relaxing product, which was most closely correlated with product C. Thus, to enhance product development based on consumers' perception, the sensory characteristics of product C may serve as a representative model. This study successfully presents detailed data on the sensory and emotional profiles of *tepache*, as well as the correlations and their influence on consumers' perception. However, a further evaluation should be conducted using panelists from main consumers and experts (trained panelists). Data obtained from both parties would provide more accurate and

comprehensive insights, thereby highly representing the findings in the present study.

ACKNOWLEDGEMENT

Authors would like to thank all parties who have been involved in this project and article writing assistance.

CONFLICT OF INTEREST AND FUNDING DISCLOSURE

All authors declare that there are no conflicts of interest to pursue in writing this article. This article is funded by Institute for Research and Community Services (LPPM), Universitas Negeri Medan, under The Decision Letter issued by Rector of Universitas Negeri Medan in 2024, No. 00299/UN33.8/KPT/2024.

AUTHOR CONTRIBUTIONS

CP: Conceptor, supervising, methodology, revising and editing the original article, formal analysis; IAS: Methodology, drafting the original article, formal

analysis; LRN: drafting the original article, formal analysis, resources.

REFERENCES

- Randazzo, W. et al. Development of New Non-Dairy Beverages from Mediterranean Fruit Juices Fermented with Water Kefir Microorganisms. *Food Microbiol* **54**, 40–51 (2016). 10.1016/j.fm.2015.10.018.
- Ligenza, A., Jakubczyk, K., Kochman, J. & Janda, K. Health-Promoting Potential and Microbial Composition of Fermented Drink Tepache. *Medycyna Ogólna i Nauki o Zdrowiu* **27**, 272–276 (2021). 10.26444/monz/138713.
- Grand View Research. *Fermented Beverage Market Size, Share & Trends Analysis Report by Product (Alcoholic, Non-Alcoholic), by Distribution Channel (Hypermarkets & Supermarkets, Online, Convenience Store), by Region, and Segment Forecasts, 2021 - 2028*. (2024).
- Hujjatusnaini, N. et al. Inovasi Minuman Tepache Berbahan Baku Kulit Nanas (Ananas comosus (L.) Merr.) Tersuplementasi Probiotik Lactobacillus casei. *Jurnal Teknologi Pangan dan Gizi* **21**, 47–54 (2022). 10.33508/jtgp.v21i1.3568.
- Rahmawati, D., A. N., & L. H. N. Development of Taste and Aroma Attributes for Mayonnaise by Quantitative Descriptive Analysis. *Indonesian Journal of Food Quality* **2**, 80–86 (2015).
- Faye, P. et al. An Alternative to External Preference Mapping Based on Consumer Perceptive Mapping. *Food Qual Prefer* **17**, 604–614 (2006). 10.1016/j.foodqual.2006.05.006.
- Reinbach, H. C., Giacalone, D., Ribeiro, L. M., Bredie, W. L. P. & Frøst, M. B. Comparison of Three Sensory Profiling Methods Based on Consumer Perception: CATA, CATA with Intensity and Napping®. *Food Qual Prefer* **32**, 160–166 (2014). 10.1016/j.foodqual.2013.02.004.
- Worch, T., Lê, S. & Punter, P. How Reliable are The Consumers? Comparison of Sensory Profiles from Consumers and Experts. *Food Qual Prefer* **21**, 309–318 (2010). 10.1016/j.foodqual.2009.06.001.
- Meiselman, H. L. A review of the Current State of Emotion Research in Product Development. *Food Research International* **76**, 192–199 (2015). 10.1016/j.foodres.2015.04.015.
- Jiang, Y., King, J. M. & Prinyawiwatkul, W. A Review of Measurement and Relationships Between Food, Eating Behavior and Emotion. *Trends Food Sci Technol* **36**, 15–28 (2014). 10.1016/j.tifs.2013.12.005.
- Najini, R. et al. Minuman Probiotik Tepache dari Fermentasi Kulit Buah Nanas (Ananas comosus L.) Menggunakan Variasi Jenis dan Konsentrasi Gula. *Journal Pharmacy Of Tanjungpura* **1**.
- Belusso, A. C., Nogueira, B. A., Breda, L. S. & Mitterer-Dalton, M. L. Check All That Apply (CATA) as an Instrument for The Development of Fish Products. *Food Science and Technology* **36**, 275–281 (2016). 10.1590/1678-457X.0026.
- Lawless, H. T. & Heymann, H. Principles of Good Practice. in 57–77 (2010). doi:10.1007/978-1-4419-6488-5_3.
- Meyners, M., Castura, J. C. & Carr, B. T. Existing and New Approaches for The Analysis of CATA Data. *Food Qual Prefer* **30**, 309–319 (2013). 10.1016/j.foodqual.2013.06.010.
- Oliveira, D. et al. Sugar Reduction in Probiotic Chocolate-Flavored Milk: Impact on Dynamic Sensory Profile and Liking. *Food Research International* **75**, 148–156 (2015). 10.1016/j.foodres.2015.05.050.
- Alcaire, F. et al. Comparison of Static and Dynamic Sensory Product Characterizations Based on Check-All-That-Apply Questions with Consumers. *Food Research International* **97**, 215–222 (2017). 10.1016/j.foodres.2017.04.012.
- Wierenga, M. R., Crawford, C. R. & Running, C. A. Older-Adults Like Sweetened Colas, but Not Other Chemesthetic Beverages. *J Texture Stud* **51**, 722–732 (2020). 10.1111/jtxs.12549.
- Viana, R. O., Magalhães-Guedes, K. T., Braga, R. A., Dias, D. R. & Schwan, R. F. Fermentation Process for Production of Apple-Based Kefir Vinegar: Microbiological, Chemical and Sensory Analysis. *Brazilian Journal of Microbiology* **48**, 592–601 (2017). 10.1016/j.bjm.2016.11.006.
- Ares, G., Dauber, C., Fernández, E., Giménez, A. & Varela, P. Penalty Analysis Based on CATA Questions to Identify Drivers of Liking and Directions for Product Reformulation. *Food Qual Prefer* **32**, 65–76 (2014). 10.1016/j.foodqual.2013.05.014.
- Ramadana, M. M., Laila, I., Halim, M. G., Ubaedilah, N. A. & Supriyatna, A. Pengaruh Konsentrasi dan Jenis Gula Terhadap Minuman Fermentasi Kulit Nanas (Tepache). *Algoritma : Jurnal Matematika, Ilmu pengetahuan Alam, Kebumihan dan Angkasa* **3**, 142–151 (2024). 10.62383/algoritma.v3i1.362.
- Nugraeni, D. A. & Nurhayati, S. F. Analisis Produksi Tepache dan Strategi Pemasarannya. *Determinasi: Jurnal Penelitian Ekonomi Manajemen dan Akuntansi* **3**, 78–91 (2025). 10.23917/determinasi.v3i1.389.
- Pratiwi, C., Saufani, I. A. & Nurfaziah, L. R. Identifikasi Profil Sensori Ideal Minuman Fermentasi Kulit Buah Nanas (Ananas comosus L.). *Amerta Nutrition* **8**, 344–352 (2024). 10.20473/amnt.v8i3SP.2024.344-352.
- McDuff, D., Kaliouby, R. El, Cohn, J. F. & Picard, R. W. Predicting Ad Liking and Purchase Intent: Large-Scale Analysis of Facial Responses to Ads. *IEEE Trans Affect Comput* **6**, 223–235 (2015). 10.1109/TAFFC.2014.2384198.