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Quality evaluation of cuko pempek based on physics and chemical properties and sensory acceptance

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ABSTRACT

This study investigated the relationship between physics and chemical properties and sensory quality of cuko pempek, a traditional chili–tamarind sauce from Palembang, and assessed its potential contribution to micronutrient intake. Ten samples of cuko from different small-scale producers were analyzed for fructose, moisture, viscosity, and sensory attributes. Correlation and regression analyses revealed that fructose, viscosity, and moisture jointly explained about 70% of the variance in taste preference, with fructose emerging as the dominant driver of consumer acceptance. Principal Component Analysis (PCA) further identified a single quality dimension defined by fructose and viscosity, confirming the close integration of chemical and sensory characteristics. Secondary data analysis showed that a 15 g serving of cuko pempek contributes approximately 0.30–0.38 mg Fe (4–5% RDA), 0.03–0.15 mg Zn (1–5% RDA), and 1.8–8 mg vitamin C (12–50% RDA) for children aged 1–5 years. While modest in absolute terms, vitamin C from tamarind and chili enhances non-heme iron absorption from fish-based pempek, positioning cuko pempek as not only a flavor enhancer but also a functional condiment. In conclusion, cuko pempek quality is primarily determined by fructose concentration and viscosity, while its micronutrient profile—particularly vitamin C—supports improved iron bioavailability. Standardizing formulation and exploring targeted fortification (Fe, Zn) represent practical strategies to maximize both sensory quality and nutritional impact. These findings suggest that cuko pempek holds potential as a culturally relevant food to support nutrition-sensitive interventions, including stunting prevention in Indonesia.

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INTRODUCTION

Cuko pempek is a traditional sauce originating from Palembang that plays a central role in defining the sensory identity of pempek as a regional food product. The characteristic profile of cuko pempek is formed by a combination of sweetness, sourness, and spiciness derived from palm sugar, tamarind, chili, and garlic. Variations in ingredient proportions and cooking practices among small-scale producers result in noticeable differences in product quality, particularly because traditional food processing is generally conducted without standardized procedures (Gunasekaran & Ak, 2000). These conditions lead to variations in taste intensity, color development, aroma characteristics, and texture among products available in local markets.

The quality of liquid and semi-liquid sauces is strongly determined by the interaction between physics and chemical characteristics and sensory perception. Parameters such as sugar content, moisture level, and viscosity are widely recognized as fundamental factors shaping flavor balance, mouthfeel, and consumer acceptance (Lawless & Heymann, 2010; Kettenmann et al., 2020). Simple sugars, including fructose, contribute to sweetness perception and participate in thermal reactions that enhance flavor complexity, while moisture and viscosity regulate dilution effects and flavor release during consumption (Tsikritzi et al. 2015). Although cuko pempek is traditionally associated with a sweet–sour taste profile, acidity parameters were not directly considered in this study because preliminary observations indicated relatively limited variation in tamarind-derived acidity among producers, whereas sugar concentration, moisture content, and viscosity exhibited greater variability and were therefore expected to exert a stronger influence on sensory acceptance.

Previous studies on cuko pempek have primarily focused on descriptive sensory characteristics and consumer preference. Syukri et al. (2014) reported that the balance between sweetness and acidity plays an important role in determining acceptability, while more recent studies by Budianto et al. (2024) and Syaiful et al. (2025) highlighted sensory variability among products produced by small-scale vendors. However, these studies relied largely on descriptive or hedonic approaches and did not quantitatively relate physics and chemical parameters to sensory attributes using multivariate statistical methods, resulting in limited understanding of how specific compositional factors jointly structure product quality.

Multivariate statistical approaches such as correlation analysis, regression modeling, and Principal Component Analysis (PCA) have been widely applied in food science to identify dominant quality drivers and to describe complex relationships between composition and sensory perception (Hair et al., 2014; Næs et al., 2018). These approaches are particularly suitable for traditional foods, where multiple parameters interact simultaneously and quality variation is often substantial. Nevertheless, the application of such multivariate frameworks to traditional Indonesian sauces, including cuko pempek, remains limited.

This study aims to evaluate the relationships between selected physics and chemical parameters—namely fructose content, moisture content, and viscosity—and the sensory attributes of cuko pempek. Specifically, the study examines correlations between physics and chemical characteristics and sensory scores, evaluates the combined influence of these parameters on flavor through regression analysis, and identifies dominant quality dimensions using PCA. Through this integrated approach, the study seeks to provide a quantitative basis for understanding quality variation in cuko pempek and to support efforts toward improving product consistency among small-scale producers.

METHODS

Materials and Sample Collection

Cuko pempek samples were obtained from small-scale producers located in several districts of Palembang, South Sumatra. A total of ten samples were collected, each representing an independent production batch prepared using traditional household-scale methods. The samples were selected to reflect variability in formulation and processing practices commonly found in local markets. The sampling locations included traditional markets and home-based production units, and no two samples originated from the same producer to ensure independence among observations. All samples were transported to the laboratory in sealed containers and stored at refrigerated temperature prior to analysis. Physicochemical and sensory evaluations were

conducted within 24 hours after sample collection to minimize quality changes during storage.

Equipment

Brookfield viscometer (Model DV-E, Brookfield Engineering), oven (Memmert, Germany), HPLC system (Shimadzu, Japan) equipped with C18 column and refractive index detector, analytical balance (±0.0001 g), and glassware were used.

Physics and Chemical Analysis

Physics and chemical analyses focused on parameters expected to influence sensory quality, namely fructose content, moisture content, and viscosity. Fructose content was determined using standard analytical procedures for soluble sugar quantification, and the results were expressed as percentage (% w/w). Moisture content was measured using the oven-drying method until constant weight was achieved, following established food analysis protocols (Gunasekaran & Ak, 2000). Viscosity was measured at room temperature using a rotational viscometer, and the results were reported in centipoise (cP), as commonly applied in the evaluation of liquid and semi-liquid food systems (Kettenmann et al., 2020).

Moisture content determined by gravimetric method using oven drying at 105 °C until constant weight (AOAC, 2005). Fructose content measured using HPLC with C18 column and RI detector. The mobile phase was acetonitrile: water (75:25 v/v) at 1 mL/min, injection volume 20 µL. Fructose concentration was calculated against standard solutions (AOAC, 2005). Viscosity measured using Brookfield viscometer at 25 °C with spindle No. 2 at 50 rpm (Gunasekaran & Ak, 2000).

Acidity parameters such as pH or titratable acidity were not included in this study because preliminary observations indicated relatively limited variation in tamarind-derived acidity among samples prepared using similar traditional formulations. In contrast, sugar concentration, moisture content, and viscosity showed greater variability and were therefore selected as primary analytical parameters. All physics and chemical measurements were conducted in triplicate, and the results were expressed as mean values.

Sensory Evaluation

Sensory evaluation was performed to assess color, aroma, and flavor attributes of the cuko pempek samples. The evaluation involved 30 untrained panelists who were familiar with pempek and cuko consumption. Samples were presented in randomized order under controlled conditions, and panelists were instructed to evaluate each attribute independently.

A five-point hedonic scale was used, ranging from 1 (very dislike), 2 (dislike), 3 (neutral), 4 (like), to 5 (like very much), following standard sensory evaluation practices (Lawless & Heymann, 2010). Each sensory score represents the mean response of all panelists for each sample.

Data Analysis

Descriptive statistics were used to summarize physics and chemical and sensory data. Pearson correlation analysis was conducted to evaluate relationships between physics and chemical parameters and sensory attributes. Multiple linear regression analysis was applied to examine the combined influence of fructose content, moisture content, and viscosity on flavor scores. The regression model was expressed in linear form to quantify the direction and magnitude of each predictor's contribution.

Principal Component Analysis (PCA) was employed to identify dominant quality dimensions and to describe the multivariate structure of the dataset. The suitability of the data for PCA was evaluated using the Kaiser–Meyer–Olkin (KMO) measure and Bartlett's test of sphericity. Component extraction was based on eigenvalues greater than one, supported by scree plot interpretation, in accordance with standard multivariate analysis guidelines (Hair et al., 2014; Næs et al., 2018). Statistical analyses were performed using SPSS software.

RESULTS AND DISCUSSION

Physics and Chemical Characteristics of Cuko Pempek

Table 1 presents the physics and chemical characteristics of the ten cuko pempek samples analyzed in this study. The fructose content showed noticeable variation among samples, ranging from 2.02% to 5.01%, with a mean value of 3.16%. This variation reflects differences in the amount and quality of palm sugar used, as well as differences in heating duration during preparation.

Thermal processing of palm sugar promotes sucrose inversion and partial caramelization, leading to increased levels of reducing sugars such as fructose, which serve as important sweetness precursors in traditional sauces (Tsikritzi et al. 2015).

The moisture content ranged from 45.90% to 61.18%, with an average of 51.52%, indicating variability in dilution practices among small-scale producers. Higher moisture levels suggest increased water addition or shorter evaporation times during cooking. Moisture plays a critical role in determining the physical state of liquid foods, as it influences the concentration of dissolved solids, viscosity, and heat transfer behavior during processing (Gunasekaran & Ak, 2000). The relatively wide moisture range observed in this study highlights the lack of formulation standardization among producers, which may contribute to downstream differences in texture and sensory perception.

Viscosity values varied substantially, from 14.33 cP to 42.87 cP, with a mean of 23.66 cP. These differences are associated with variations in sugar concentration, moisture content, and boiling intensity. Viscosity is a fundamental physical parameter that reflects the structural and flow behavior of liquid foods and is commonly used as an indicator of consistency and physical stability (Kettenmann et al., 2020). At this stage, the reported viscosity values primarily illustrate production diversity rather than quality ranking.

Table 1 Physics and chemical Properties of Cuko Pempek

Sample	Fructose (%)	Moisture (%)	Viscosity (cP)
F1	5.01	45.90	42.87
F2	2.15	57.45	22.31
F3	4.10	50.64	37.85
F4	2.02	61.18	14.33
F5	2.98	52.43	28.95
F6	2.50	49.86	16.35
F7	3.38	47.42	19.27
F8	3.31	49.25	16.10
F9	3.95	51.51	19.83
F10	2.19	49.52	18.76
Mean	3.16	51.52	23.66

Source: Primary Data Processed (2025)

Table 2 Sensory Attributes of Cuko Pempek

Sample	Color	Aroma	Flavor
F1	3.93	3.50	3.56
F2	3.00	3.64	2.94
F3	3.83	3.14	3.26
F4	3.23	3.52	3.00
F5	3.20	3.64	3.43
F6	3.43	3.40	3.29
F7	3.13	3.32	3.32
F8	3.80	3.50	3.16
F9	3.17	3.56	3.34
F10	2.90	3.40	3.10
Mean	3.36	3.46	3.24

Source: Primary Data Processed (2025)

Table 3 Summary of Statistical Findings for Cuko Pempek Quality

Analysis Type	Key Numerical Results	Essential Interpretation
Correlation Analysis	● Strong positive: Fructose–Flavor ($r = 0.788$; $p < 0.01$) ● Positive: Fructose–Viscosity ($r = 0.745$; $p < 0.05$) ● Negative: Moisture–Flavor ($r = -0.716$; $p < 0.05$) ● Negative: Moisture–Color ($r = -0.688$; $p < 0.05$)	Fructose acts as a strong enhancer of flavor, viscosity, and color; moisture suppresses sensory quality.
Regression Analysis	● $R^2 = 0.700$; $F = 4.668$; $p = 0.052$ ● Coefficients: Fructose (+), Viscosity (+), Moisture (–)	70% of flavor variation explained collectively by physicochemical attributes, despite borderline significance.
PCA	● One major component ● Eigenvalue = 3.585; Variance explained = 59.7% ● Loadings: Fructose (0.935), Flavor (0.843), Viscosity (0.792), Color (0.767), Moisture (–0.779)	Single underlying quality dimension dominated by fructose, viscosity, and low moisture content.

Source: Primary Data Processed (2025)

Sensory Characteristics of Cuko Pempek

The sensory evaluation results for color, aroma, and flavor are summarized in Table 2. Color scores ranged from 2.90 to 3.93, with a mean of 3.36, indicating generally acceptable and relatively uniform visual appearance across samples. Variations in color intensity are mainly associated with differences in caramelization of palm sugar and the extraction of pigments from chili and tamarind during heating. Similar findings have been reported in studies of sugar-based traditional sauces, where thermal treatment significantly affects browning reactions and color stability (Purohit et al. 2023; Luo et al. 2024). The relatively low standard deviation of color scores suggests that visual appearance was less sensitive to formulation differences than other sensory attributes.

Aroma scores showed a narrower range, from 3.14 to 3.64, with a mean value of 3.46. This consistency indicates that the aromatic profile of cuko pempek is largely preserved across different formulations. Volatile compounds originating from garlic, chili, and tamarind dominate the aroma profile and tend to remain stable under moderate heating conditions. Previous studies on traditional sauces have shown that although heating can modify volatile composition, core aroma characteristics often remain recognizable across formulations (Purohit et al. 2023; Luo et al. 2024). The importance of aroma as a contributor to overall flavor perception is well documented in sensory science literature (Lawless & Heymann, 2010; Spence, 2018).

Flavor scores exhibited the greatest variability, ranging from 2.94 to 3.56, with an average of 3.24. This variation reflects differences in the balance between sweetness, sourness, saltiness, and pungency that define the characteristic taste of cuko pempek. Small changes in palm sugar concentration, tamarind extract, and chili content can lead to perceptible shifts in flavor intensity. Similar variability has been reported in artisanal condiment systems, where ingredient ratios and cooking duration strongly influence flavor perception (Tsikritzi et al. 2015). The higher standard deviation observed for flavor compared to color and aroma indicates that flavor is the most formulation-sensitive sensory attribute in cuko pempek.

Statistical Relationships between Physics and Chemical Parameters and Sensory Attributes

The statistical analysis provides a quantitative description of how variations in

physics and chemical parameters are associated with sensory outcomes. Correlation analysis revealed a strong and significant positive relationship between fructose content and flavor score ($r = 0.788$; $p = 0.007$), indicating that higher sugar concentrations are consistently associated with higher flavor acceptance. Fructose was also positively correlated with viscosity ($r = 0.745$; $p = 0.013$) and color ($r = 0.706$; $p = 0.022$), suggesting that sugar concentration co-varies with both physical thickness and visual intensity.

Based on the multiple linear regression analysis, the relationship between physical and chemical parameters and flavor can be expressed by the following Equation (1)

$$Flavor = 3.710 + 0.086(Fructose) - 0.016(Moisture) + 0.003(Viscosity). \quad (1)$$

This equation indicates that increases in fructose and viscosity are associated with higher flavor scores, whereas higher moisture content contributes negatively to flavor perception when other variables are held constant. Although individual coefficients were not statistically significant due to the limited sample size, the equation reflects the same directional relationships observed in the correlation analysis.

Moisture content exhibited significant negative correlations with flavor ($r = –0.716$; $p = 0.020$) and color ($r = –0.688$; $p = 0.022$). These numerical relationships indicate that higher dilution levels are associated with reduced sensory intensity. Although correlation analysis does not explain causality, it quantifies the strength and direction of co-variation between variables within the dataset. Viscosity showed a moderate positive correlation with flavor ($r = 0.610$; $p = 0.061$), suggesting a directional association that did not reach statistical significance but remains relevant in the context of integrated quality assessment.

Multiple linear regression analysis further clarified the combined influence of physics and chemical parameters on flavor perception. The regression model explained 70% of the variability in flavor scores ($R^2 = 0.700$), indicating that fructose content, moisture content, and viscosity collectively exert substantial influence on sensory outcomes. The regression coefficients showed positive contributions from fructose and viscosity, and a negative contribution from moisture, reinforcing the directional trends observed in the correlation analysis. Although the overall model significance was marginal ($p = 0.052$), the magnitude of explained variance suggests that the selected predictors capture meaningful quality-related variation in cuko pempek.

Principal Component Analysis (PCA) revealed a single dominant component with an eigenvalue of 3.585, explaining 59.7% of the total variance. High positive loadings were observed for fructose, flavor, viscosity, and color, while moisture showed a strong negative loading.

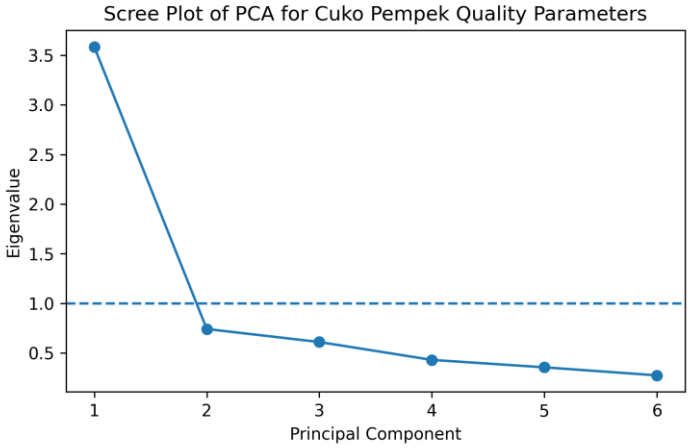


Figure 1 Scree Plot Cuko Pempek

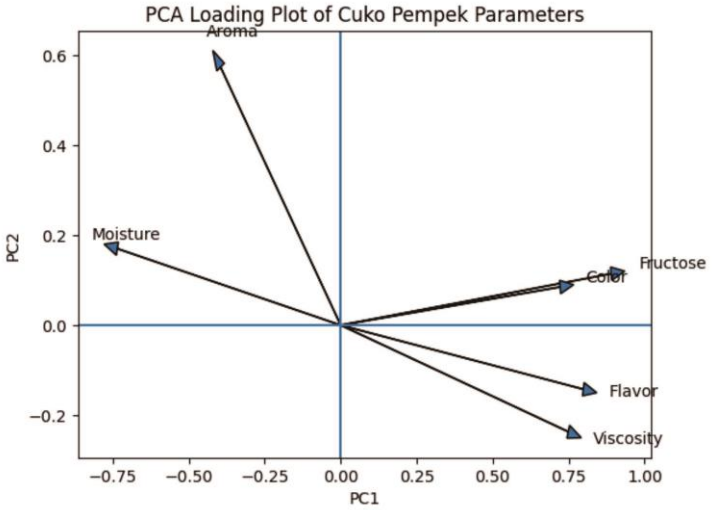


Figure 2 PCA Loading Plot Cuko Pempek

The scree plot (Figure 1) shows a sharp decline in eigenvalues after the first component, with Component 1 exceeding the Kaiser criterion, while subsequent components fall below the threshold. This pattern confirms that a single principal component adequately represents the variance structure of the dataset.

Figure 2. PCA loading plot showing the distribution of physical, chemical, and sensory parameters along the first two principal components. Fructose, viscosity, color, and flavor load positively on PC1, while moisture loads negatively, indicating an integrated quality dimension dominated by sugar concentration and textural consistency.

The scree plot (Figure 1) displayed a sharp decline after the first component, confirming that only one principal component met the Kaiser criterion. This statistical structure demonstrates that the analyzed variables cluster along a single integrated axis of variation rather than forming multiple independent dimensions.

Figure 2 presents the PCA loading plot illustrating the relationships among physics and chemical parameters and sensory attributes of cuko pempek. Variables with vectors pointing in similar directions, such as fructose, viscosity, color, and flavor, indicate strong positive associations and collective contribution to the first principal component. In contrast, moisture content is positioned in the opposite direction, confirming its inverse relationship with sensory intensity. The dominance of PC1 reflects an integrated quality dimension governed primarily by sugar concentration and textural consistency, while PC2 captures minor variability related to aroma.

Integrated Quality Interpretation of Cuko Pempek Based on Physical, Chemical, and Sensory Attributes

The integrated quality profile of cuko pempek emerges from the interaction between its physical and chemical composition and the way these attributes are perceived sensorially by consumers. Rather than being governed by a single parameter, product quality is shaped by a coordinated balance between sweetness intensity, dilution level, and textural consistency, which together define the characteristic flavor identity of this traditional Palembang condiment. The multivariate structure observed in this study confirms that variations in quality among samples reflect systemic differences in formulation and processing practices rather than isolated changes in individual attributes.

Fructose content functions as the central driver within this integrated quality system. Its strong positive association with flavor perception, along with its dominant contribution in the principal component structure, indicates that soluble sugars play a pivotal role in anchoring overall sensory acceptance. In cuko pempek, fructose is not only a source of sweetness but also an indirect marker of palm sugar concentration and thermal treatment intensity. Heating and partial caramelization of palm sugar generate both simple sugars and flavor-active compounds, which collectively enhance taste complexity and palatability. This role of sugars as key determinants of sensory quality is consistent with

established findings in traditional sauce systems, where sweetness–acidity balance governs consumer preference and flavor harmony (Tsikritzi et al. 2015; Spence, 2018).

Moisture content exerts an opposing influence within the same quality dimension. The consistent negative relationship between water content and sensory performance indicates that excessive dilution weakens the expression of flavor and visual intensity. From a physical and chemical perspective, higher moisture levels reduce the concentration of dissolved solids and volatile compounds, thereby diminishing sensory impact. Within the integrated quality framework, moisture acts not as an independent quality attribute but as a moderating factor that constrains the effectiveness of sugar-derived flavor compounds. This interpretation aligns with broader principles of liquid food systems, where water content directly affects flavor concentration, stability, and consumer perception (Gunasekaran & Ak, 2000).

Viscosity plays a reinforcing role in mediating the relationship between chemical composition and sensory perception. Although its direct statistical association with flavor did not reach conventional significance thresholds, its consistent positive alignment with flavor, color, and fructose within the principal component structure suggests that textural properties enhance sensory integration. Increased viscosity slows flavor release and prolongs oral exposure, thereby intensifying perceived taste and mouthfeel. In traditional condiments, such structural attributes are often shaped by heating duration and sugar concentration, linking viscosity closely to both formulation and processing decisions. The contribution of viscosity to perceived quality observed here corresponds with sensory science literature emphasizing its importance in flavor persistence and consumer liking (Lawless & Heymann, 2010; Kettenmann et al., 2020).

Color and aroma function as supportive sensory cues within the same integrated quality dimension. Their co-variation with fructose and viscosity indicates that visual and aromatic characteristics are indirectly governed by similar processing factors, particularly thermal treatment and ingredient concentration. While these attributes did not emerge as primary drivers of variation, their alignment within the dominant component highlights the multisensory nature of quality perception, where visual, aromatic, and gustatory cues collectively shape overall acceptance. Such multisensory integration is a defining feature of traditional foods, in which quality is evaluated holistically rather than through isolated attributes (Næs et al., 2018).

The identification of a single dominant component through PCA, as confirmed by the scree plot, underscores that the quality of cuko pempek can be represented as an integrated construct rather than a set of independent variables. This construct reflects a balance between high soluble sugar content, controlled moisture, and sufficient viscosity, which together produce a concentrated, stable, and sensorially rich product. From a methodological perspective, this finding supports the use of multivariate approaches to capture the complexity of traditional food quality, where linear, single-variable assessments may fail to represent consumer-relevant outcomes (Hair et al., 2014).

From a practical standpoint, the integrated interpretation suggests that improving cuko pempek quality does not require radical changes in formulation but rather targeted control of key parameters. Optimizing palm sugar concentration, managing heating duration to reduce unnecessary dilution, and achieving consistent viscosity can collectively enhance sensory performance and product consistency. These implications are particularly relevant for small-scale and artisanal producers, where standardization of critical processing steps can improve quality without compromising traditional identity. Similar recommendations have been emphasized in studies on traditional condiment systems, where modest process control significantly improves consumer acceptance and marketability (Olusanya et al., 2020).

Overall, this integrative analysis demonstrates that the quality of cuko pempek is governed by a coherent interaction between physical, chemical, and sensory attributes. By framing quality as a unified dimension shaped by compositional balance and processing practices, the present study provides a scientific basis for quality optimization while preserving the traditional character of this regional food product.

CONCLUSION

This study demonstrates that the quality of cuko pempek is governed by an integrated interaction between physical and chemical

characteristics and sensory perception rather than by isolated attributes. The combined analyses reveal that variations in product quality among samples are structured along a single dominant quality dimension, reflecting differences in formulation and processing practices among small-scale producers.

Within this integrated framework, fructose emerges as the primary driver of flavor acceptance, functioning as both a sweetness contributor and an indicator of palm sugar concentration and thermal processing intensity. Moisture content consistently exerts a counteracting influence by diluting flavor-active compounds, while viscosity reinforces sensory perception through its role in mouthfeel and flavor retention. Together, these parameters form a coherent balance that shapes the overall sensory profile of cuko pempek.

The application of correlation analysis, multiple regression, and principal component analysis provides complementary perspectives that collectively capture the complexity of quality formation in this traditional sauce. The identification of a single dominant quality dimension underscores the suitability of multivariate approaches for evaluating traditional foods, where quality perception arises from the interaction of multiple physical, chemical, and sensory factors.

From a practical standpoint, the findings suggest that improving cuko pempek quality does not require fundamental changes to traditional formulations, but rather targeted control of key parameters, particularly palm sugar concentration, moisture management during cooking, and consistency of viscosity. Such process-oriented optimization can enhance product consistency and consumer acceptance while preserving the traditional identity of cuko pempek. Overall, this study offers a scientific basis for quality evaluation and improvement of traditional Indonesian condiments through integrated physical, chemical, and sensory analysis.

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REFERENCES

AOAC International. 2005. Official methods of analysis of AOAC International (18th ed). AOAC International.

Budianto, B., Pratama, F., Syafutri, M. I. 2024. Taste sensitivity changes among consumers of pempek-cuko in Palembang City, South Sumatra, Indonesia. *Russian Journal of Agricultural and Socio-Economic Sciences*, 148(4), 98–106.

Field A. 2009. Discovering statistics using SPSS (3rd ed). SAGE Publications.

Gunasekaran S, Ak MM. 2000. Viscosity of foods: principles, measurements, and applications. Springer.

Hair JF, Black WC, Babin BJ, Anderson RE. 2014. Multivariate data analysis (7th ed). Pearson Education Limited.

Kettenmann A, Hummel T, Croy I. 2020. The role of texture and viscosity in flavor perception and food acceptance. Food Quality and Preference, 80, 103793.

Lawless HT, Heymann H. 2010. Sensory evaluation of food: principles and practices (2nd ed). Springer.

Luo, H., Y. Wu, J. Jin, L. Zhang, S. Tong, C. Li, Q. Tan, and Q. Han. 2024. Characterization of key aroma compounds of fried pepper sauce under different pretreatment processes. RSC Advances 14(23):16368–16378. https://doi.org/10.1039/D4RA02343A.

Næs T, Brockhoff PB, Tomic O. 2018. Statistics for sensory and consumer science. Wiley.

Olusanya JO, Uvere PO, Ezeokeke CT. 2020. Traditional condiments as vehicles for food fortification: opportunities and challenges. Food Research International, 137, 109689.

Purohit, A., M. Jain, S. Sarkhel, A. Roy, and A. Mohan. 2023. Determination of quality kinetics, microbiology, and sensory properties of shelf-stable chicken-wing sauce. Frontiers in Food Science and Technology 3. https://doi.org/10.3389/frfst.2023.1204804.

Spence C. 2018. Multisensory flavor perception. Cell, 161(1), 24–35.

Syaiful, F., T. N. Maharani, and M. I. Syafutri. 2025. Physicochemical and Sensory

Characteristics of Cuko Pempek with The Addition of Organic Acid. Journal of Applied Food Technology 12(1):80–84. https://doi.org/10.17728/jaft.25184.

Syukri, A. S., S. Suyatno, and M. T. H. Handi. 2014. Karakteristik Kimia, Fisika dan Organoleptik Cuko Pempek Bubuk dari Berbagai Formulasi Gula Semut dan Sukrosa Chemical, Physical, And Organoleptic of Cuko Pempek Powder from Sugar Ants and Sucrose Formulation. Edible: Jurnal Penelitian Ilmu-ilmu Teknologi Pangan 3(1):12–16. https://doi.org/10.32502/jedb.v3i1.145.

Tsikritzi, R., J. Wang, V. J. Collins, V. J. Allen, Y. Mavrommatis, P. J. Moynihan, M. A. Gosney, O. B. Kennedy, and L. Methven. 2015. The effect of nutrient fortification of sauces on product stability, sensory properties, and subsequent liking by older adults. Journal of Food Science 80(5):S1100-1110. https://doi.org/10.1111/1750-3841.12850.