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Principal Component Analysis (PCA) of Consumer Sensory Preferences for Palembang Fish Crackers

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Abstract

Palembang fish crackers (kemplang) are traditional food products that have undergone various ingredient and processing modifications, potentially influencing consumers' perceptions of their sensory attributes. This study used Principal Component Analysis (PCA) to explore patterns of consumer liking and map the sensory preference profiles of ten fried peser-type fish cracker samples obtained from different producers in Palembang City. Fifty panelists evaluated color, aroma, taste, crispness, and overall acceptance using a three-point hedonic scale. Mean scores for each attribute and sample were aggregated into a 10 × 5 data matrix and standardized using z-scores before PCA. The first two principal components explained 94.81% of the total variance, with PC1 accounting for 72.48% and PC2 for 22.34%. PC1 was mainly associated with overall acceptance, taste, crispness, and aroma, whereas PC2 was primarily associated with color. The biplot illustrated similarities and differences among the sampled products in the two-component space. These findings provide an exploratory map of consumer sensory preferences rather than definitive standards of product quality or sensory identity. Further research using descriptive sensory analysis, objective texture measurements, and a broader range of products and consumers is needed to validate and extend these findings.

Keywords: *Palembang fish crackers; consumer sensory preferences; hedonic test; multivariate analysis; principal component analysis.*

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INTRODUCTION

Palembang fish crackers, commonly known as kemplang, are a traditional snack from South Sumatra, particularly Palembang City. This food is made from a mixture of tapioca, minced fish meat, salt, and seasoning (Guttifera et al., 2020). Compared with fish crackers in general, Palembang fish crackers have distinctive characteristics: they are round and flat, approximately 0.5 to 1 cm thick, have a savory taste and a strong fish aroma, and a crispy texture. Initially, Palembang fish crackers were produced using belida fish as the main raw material. However, due to the decline in the belida fish population in the waters of the Musi River, the use of this fish has decreased and it has been replaced by other fish species, such as mackerel, snapper, snakehead fish, and putak fish (Kartika & Harahap, 2019). The production process of Palembang fish crackers begins with mixing the ingredients, preparing the dough, shaping it into long cylindrical rolls (lenjeran), steaming, slicing it into pieces, drying, and frying (Pristiansyah et al., 2023).

Today, the presence and popularity of Palembang fish crackers are no longer limited to their region of origin but have spread to various parts of Indonesia. This indicates that Palembang fish crackers have high cultural and economic value and have the potential to be developed as a regional flagship product. In the market, Palembang fish crackers are available in various types and shapes, including peser, kancing, mini, and mangkok. In addition to being cooked by frying, Palembang fish crackers are also available in a roasted variant.

Traditionally, Palembang fish crackers are cooked through two frying stages: the first frying uses moderately heated oil at a temperature of 80-100 °C, followed by a second frying in hot oil at 160-200 °C (Koswara et al., 2017). This method is considered less practical, so many producers modify the product by reducing the thickness of the fish crackers to less than 0.5 cm. However, this change in thickness can affect sensory properties such as texture, taste, color, and aroma, which generally characterize thick fish crackers.

In addition, Guttifera et al. (2022) developed an alternative method for cooking Palembang fish crackers by replacing frying with a microwave oven to simplify the cooking process compared with the two-stage frying method. Various ingredient modifications have also been made, including the use of pumpkin in Palembang fish cracker formulations (Alhanannasir et al., 2021), the use of fish bones to improve nutritional value (Nusaibah et al., 2021; Septia et al., 2020), the use of shrimp-head broth as a flavor enhancer in Palembang fish crackers (Akbar et al., 2017), increasing fiber content by adding fiber from velvet tamarind (Cheadoloh et al., 2025), adding butterfly pea flower extract to the formulation (Pratama et al., 2022), and using green mussel meat and shell flour in the production of Palembang fish crackers (Nisa et al., 2021). However, these modifications are often not based on the product's distinctive characteristics, potentially resulting in Palembang fish crackers with characteristics that differ from the original product.

Although previous studies have developed Palembang fish crackers through ingredient and processing modifications, most have focused on formulation development and the characteristics of the modified products. Comparatively little attention has been given to consumers' liking patterns across products from different producers, particularly the relationships among sensory attributes and the differences in preference profiles between samples. Based on the literature reviewed for this study, the use of PCA to map the relationships among color, aroma, taste, crispness, and overall acceptance in Palembang fish crackers has not been specifically reported. Such information is important for understanding how products currently available in the market are perceived by consumers before further product development is undertaken.

Therefore, PCA can be used as an exploratory approach to summarize the relationships among sensory liking attributes and to visualize differences between samples. Principal Component Analysis (PCA) is a multivariate data-reduction method that transforms the original variables in a data matrix into a smaller set of new variables, or principal components, formed as linear combinations of the original variables. These components retain as much of the variation in the original data as possible (Mukuan et al., 2022). The aim of PCA is to obtain a small number of principal components that explain the largest possible proportion of the variance in the original data (Suyanto et al., 2023). In this study, the approach was used to examine patterns of association among sensory attributes and the relative positions of samples based on panelists' liking scores.

Accordingly, this study aimed to explore the relationships among consumer liking attributes and to map the sensory preference profiles of ten Palembang fish cracker samples using PCA. Specifically, it sought to identify the attributes most closely associated with overall acceptance and to describe similarities and differences among the sampled products. The findings are intended to provide preliminary information for further product development, not to establish objective quality standards or a definitive sensory identity for Palembang fish crackers.

RESEARCH METHODS

This study used a quantitative, exploratory approach with multivariate analysis through PCA. The research comprised three stages: product sampling, sensory evaluation using a hedonic test, and data analysis. The materials consisted of mineral water and fried peser-type Palembang fish crackers obtained from ten fish cracker industries in Palembang City. A preliminary site survey was conducted to identify eligible producers. Ten industries were selected according to the following criteria: each represented a different producer; each manufactured its own Palembang fish crackers rather than repackaging products made by others; all used the same cooking method, namely frying; and each held a Household Food Industry (PIRT) permit and halal certification. To protect the producers' identities, the samples were assigned alphabetical codes (A–J).

Sensory evaluation was conducted using a hedonic test involving 50 panelists. Panelists were recruited through direct invitations and selected according to predetermined criteria. They lived in Palembang City or surrounding areas, were willing and available to complete the evaluation, and reported consuming Palembang fish crackers regularly (at least 1-2 times per week). They had no allergies to the ingredients used in the tested products and were in good physical condition, with no reported impairments of smell, taste, or vision that could affect sensory assessment.

The hedonic test is based on panelists' subjective assessments of how much they like or dislike a product. Responses are recorded on a hedonic scale and converted into numerical scores, with higher values indicating greater liking; these scores can then be analyzed statistically (Qamariah et al., 2022).

Ten Palembang fish cracker samples were prepared for evaluation. Each cracker was placed in a clean, dry, transparent resealable plastic bag and labeled with a randomly assigned three-digit code to conceal the producer's identity. Panelists assessed five attributes color, aroma, taste, crispness, and overall acceptance and recorded their responses in a questionnaire. Mineral water was provided between samples as a palate cleanser. A three-point hedonic scale was used: 1 = dislike, 2 = like, and 3 = like very much. The scale was chosen to simplify the response categories and make it easier for panelists to express their level of liking. However, the limited number of response categories may reduce sensitivity to subtle differences in preference and is acknowledged as a limitation of this study.

Responses from the 50 panelists were compiled in Microsoft Excel. For each product, the mean score across panelists was calculated separately for each of the five sensory attributes. The resulting PCA input was a 10 × 5 matrix, with the ten products as observations (rows) and the five attributes color, aroma, taste, crispness, and overall acceptance as variables (columns). Thus, PCA was performed on product-level mean scores rather than on individual panelist ratings. The matrix was imported into RStudio version 2026.04.0+526. Before analysis, each variable was standardized using z-scores with the scale() function in RStudio to place the attributes on a comparable variance scale. PCA was then used to summarize the largest sources of variation in the sensory preference data and to map relationships between attributes and products. The number of retained components was determined using the Kaiser criterion (eigenvalues > 1), supported by the scree plot. The results were interpreted based on the proportion of variance explained, component loadings, sample scores, and the biplot.

RESULTS AND DISCUSSION

PCA was applied to the 10 × 5 matrix of product-level mean hedonic scores to explore patterns of relationships among sensory attributes and Palembang fish cracker samples. The outputs included eigenvalues, explained and cumulative variance, a scree plot, a loading matrix, sample scores, and a biplot. The eigenvalues, variance percentages, and cumulative variance are presented in Table 1.

Table 1. Eigenvalue, Variance, and Cumulative Variance

Principal Component (PC)	Eigenvalue	Variance (%)	Cumulative Variance (%)
1	3.623	72.478	72.478
2	1.116	22.335	94.814
3	0.122	2.452	97.267
4	0.093	1.878	99.145
5	0.042	0.854	100.000

Based on the results in Table 1, two principal components with eigenvalues greater than 1 were obtained. The number of principal components was determined based on Kaiser's Rule (eigenvalue > 1) and the percentage of cumulative variance explained (Tobing et al., 2026). Eigenvalue indicates the amount of data variability (information) that can be explained by each principal component. The variance proportion indicates the percentage of data variability or information explained by each principal component, while cumulative variance describes the accumulated contribution of all principal components (Ameliya et al., 2026).

Principal component 1 (PC1) had an eigenvalue of 3.623 and explained 72.48% of the variance, whereas principal component 2 (PC2) had an eigenvalue of 1.116 and explained 22.34%. Together, PC1 and PC2 accounted for 94.81% of the total variance in the product-level mean scores. PC1 was associated mainly with overall acceptance, taste, crispness, and aroma, whereas PC2 was associated primarily with color. The remaining components (PC3-PC5) had eigenvalues below 1 and contributed relatively little to the explained variance; therefore, they were not retained under the Kaiser criterion. These results summarize the variation among the ten sampled products, but the high cumulative variance should not, on its own, be interpreted as evidence that the component structure is stable or generalizable.

The selection of two principal components was also supported by the scree plot visualization in Figure 1. A scree plot displays the principal components based on their respective eigenvalues (Pratiwi

& Syarief, 2024). A scree plot is used to determine the number of principal components that should be retained based on the pattern of eigenvalue decline for each component. The term 'dimensions' in Figure 1 refers to the principal components.

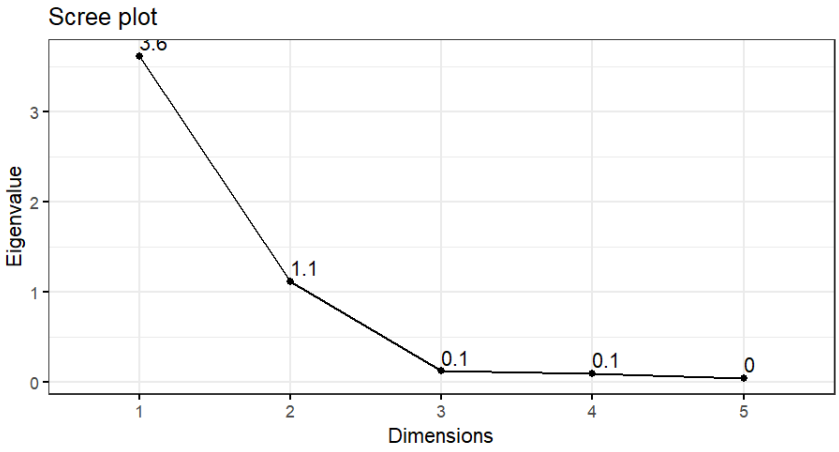


Figure 1. Scree Plot

The scree plot shows a sharp decline in eigenvalues from PC1 to PC2. PC1 has the highest eigenvalue, at 3.6, while PC2 decreases to 1.1. This sharp decline indicates that most of the information or variability in the sensory data of Palembang fish crackers can be explained by two principal components (PC1 and PC2). After PC2, the eigenvalues for PC3 to PC5 are very small and the graph begins to level off, indicating that each component explains progressively less information.

Another output generated by PCA is the loading matrix. The loading matrix presents the loading values of each variable or attribute for the principal components and is used to determine which variables make a major contribution to the formation of each principal component. The loading matrix values for PC1 and PC2 are presented in Table 2.

Table 2. Loading Matrix for PC1 and PC2

No.	Variable	PC1	PC2
1	Color	-0.176	0.881
2	Aroma	-0.474	-0.325
3	Crispness	-0.484	-0.237
4	Taste	-0.492	0.244
5	Overall Acceptance	-0.515	-0.012

Loading values closer to +1 or −1 indicate a stronger contribution of a variable to a principal component, whereas values closer to 0 indicate a weaker contribution (Cozzolino et al., 2019). The positive or negative sign indicates the direction of an attribute relative to the component axis; it does not, by itself, indicate whether the attribute is liked or disliked. As shown in Table 2, all five attributes had negative loadings on PC1. The largest absolute loadings were for overall acceptance (0.515), taste (0.492), crispness (0.484), and aroma (0.474), indicating that these attributes were most strongly associated with PC1. PC1 can therefore be interpreted as a sensory-liking dimension associated with taste, crispness, aroma, and overall acceptance. The sign of a principal component is arbitrary and can be reversed without changing the underlying relationships; accordingly, the negative loadings should be interpreted in terms of direction rather than as negative liking. On PC2, color had the largest loading (0.881), indicating that it contributed most strongly to this component. PC2 can therefore be interpreted primarily as a color-related or visual preference dimension.

Another output is the score values, which indicate the position of each sample on the principal components formed, namely PC1 and PC2, which represent most of the variation in the sensory data. The score values of all samples on PC1 and PC2 are presented in Table 3.

Table 3. PCA Score Values

No.	Sample	PC1	PC2
1	A	-1.666	0.375
2	B	0.282	0.884
3	C	-0.957	0.898
4	D	-0.382	-0.985
5	E	1.439	-2.035
6	F	-0.217	-0.197
7	G	-0.269	-0.239
8	H	4.710	0.900
9	I	-1.457	1.252
10	J	-1.481	-0.852

As shown in Table 3, sample H had the highest positive score on PC1 (4.710), placing it farthest in the positive PC1 direction. Because the four attributes most strongly associated with PC1 had negative loadings, sample H is positioned opposite to the direction of taste, crispness, aroma, and overall acceptance in the PC1 dimension; its high positive score should not be interpreted as greater liking or higher overall quality. Samples A (−1.666), J (−1.481), and I (−1.457) had the most negative PC1 scores and were located toward the direction associated with those attributes. On PC2, sample I had the highest score (1.252), followed by H (0.900), C (0.898), and B (0.884). These samples were located in the positive PC2 direction, which was associated primarily with color. Sample E had the lowest PC2 score (−2.035), placing it in the opposite direction. These scores describe the relative positions of the products in the two-component space and do not provide a definitive ranking of product quality.

The PCA biplot displays product scores and sensory-variable loadings in the same two-dimensional space (Wieldyanisa et al., 2025). The proximity of product points provides an indication of similarity in the first two component dimensions. The direction of each variable vector indicates the direction in which the corresponding attribute is associated with the component axes. The angles between vectors provide an approximate indication of relationships among attributes: acute angles suggest positive associations, angles near 90° suggest weak associations, and angles close to 180° suggest negative associations (Widowati & Muzdalifah, 2017). These interpretations are limited to the variation represented by PC1 and PC2. The biplot is presented in Figure 2.

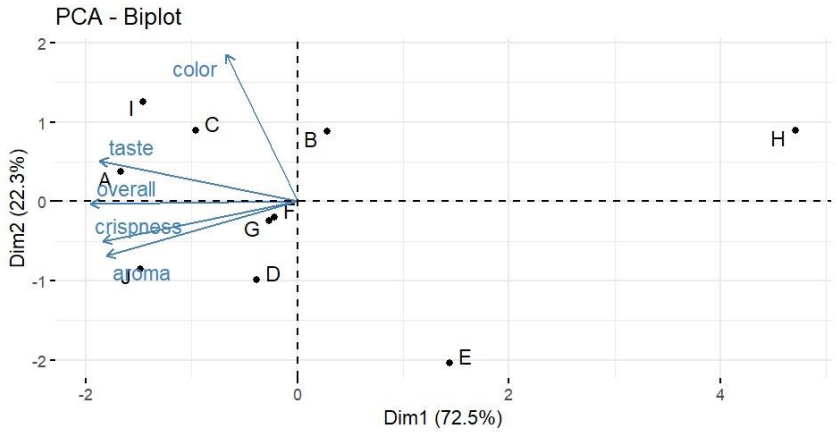


Figure 2. Biplot of PC1 and PC2

Figure 2 shows the scores of the ten Palembang fish cracker samples as points and the sensory attributes as vectors. Dim1 represents PC1, which explains 72.5% of the variance, and Dim2 represents PC2, which explains 22.3%. Together, the two components account for 94.81% of the total variance in

the product-level mean scores. The biplot therefore provides a two-dimensional summary of the variation among the sampled products and their sensory liking attributes.

Samples F and G are positioned close to one another, suggesting similar profiles in the two-component space. Samples A, I, and J have relatively similar PC1 scores but differ in their PC2 positions: sample I lies in the positive PC2 direction, whereas sample J lies in the negative PC2 direction. Thus, these three samples should not be treated as an identical cluster. Samples H and E are separated from most other samples, with H located far along positive PC1 and E located far along negative PC2, indicating distinct relative profiles in the biplot.

The vectors for taste, crispness, aroma, and overall acceptance point broadly toward the negative side of PC1 and lie relatively close to one another, suggesting positive associations among these attributes. This pattern indicates that samples positioned in the same general direction as these vectors tend to have higher liking scores for these attributes, including overall acceptance. This is consistent with previous findings that sensory attributes such as aroma, texture, and taste are related to consumer acceptance of food products Riyananda et al. (2026). In contrast, the color vector points primarily toward the positive side of PC2, indicating that color contributes a distinct dimension to the sensory preference map. These patterns represent associations within the present dataset and should not be interpreted as causal relationships.

In a biplot, a product's association with an attribute is interpreted by its projection in the direction of that attribute's vector, rather than simply by the distance between the product point and the vector. Products projected farther in the direction of a vector tend to have relatively higher standardized scores for that attribute, whereas products in the opposite direction tend to have relatively lower scores. This interpretation is relative to the ten products included in the analysis and does not establish an absolute sensory quality ranking.

Palembang fish crackers are traditionally associated with a savory taste, a distinctive fish aroma, and a crispy texture. Guttifera et al. (2023) reported that fish meat accounted for approximately 28% of the formulation in a Palembang-style fish cracker product. Fish contains proteins and amino acids, including glutamic acid, which contributes to umami (savory) taste (Andrestian et al., 2026). In addition to fish-derived compounds, monosodium glutamate (MSG) may contribute to savory taste as a flavor enhancer. MSG is reported to consist of 78% glutamate, 12% sodium, and 10% water (Sidharta et al., 2026). These ingredients may contribute to the flavor profile perceived by consumers, although the present study did not separately measure the chemical composition of the samples.

Crispness is another important sensory attribute of Palembang fish crackers. The crispy texture is associated with expansion during frying. Tapioca starch supports expansion because it contains a high proportion of amylopectin (approximately 83%). A higher amylopectin content may increase the expansion capacity of crackers. During heating, vapor pressure develops and expands the cracker structure, creating air pockets (Asikin et al., 2024). This porous structure contributes to the crisp texture.

Several limitations should be considered when interpreting these findings. The PCA was based on ten products and five sensory attributes, so the component structure should be regarded as exploratory and may be sensitive to the products included. Although PC1 and PC2 explained 94.81% of the variance in this dataset, this proportion alone does not demonstrate the stability or generalizability of the components; the analysis did not include resampling or validation using an independent product set. In addition, the three-point hedonic scale provides limited discrimination, and hedonic ratings reflect consumer liking rather than objective sensory intensity or instrumental product quality. Therefore, the results should not be treated as definitive sensory standards or as evidence that a particular modification preserves the traditional sensory identity of Palembang fish crackers. Future studies should involve a broader range of products and consumers, descriptive sensory analysis, objective texture measurements, and independent validation of the PCA structure.

CONCLUSION

The PCA of product-level mean hedonic scores from ten Palembang fish cracker samples identified two principal components that together explained 94.81% of the variance. PC1 was associated mainly with overall acceptance, taste, crispness, and aroma, whereas PC2 was associated primarily with color. The biplot provided an exploratory map of similarities and differences among the sampled products and showed that liking for taste, crispness, and aroma was associated with overall acceptance. Because the analysis was based on ten products and a three-point hedonic scale, the findings represent

preliminary patterns of consumer sensory preferences rather than objective quality standards or a definitive sensory identity. The results may inform further product development, but confirmation will require a broader product and consumer sample, descriptive sensory analysis, objective texture measurements, and validation using independent data.

REFERENCES

Akbar, Z., Riyadi, S., & Jaya, F. M. (2017). Pemanfaatan kaldu kepala udang vannamei (*Litopenaeus vannamei*) sebagai flavor dalam pengolahan kerupuk kemplang ikan lele dumbo (*Clarias gariepinus*). *Jurnal Ilmu-Ilmu Perikanan dan Budidaya Perairan*, *12*(1), 27–33. https://doi.org/10.31851/jipbp.v12i1.1411

Alhanannasir, A., Murtado, A. D., Muchsiri, M., Rudi, F., & Agustini, S. (2021). Aplikasi labu kuning sebagai substitusi zat warna kuning pada pembuatan kemplang. *Jurnal Dinamika Penelitian Industri*, *32*(1), 19–26. https://doi.org/10.28959/jdpi.v32i1.6896

Ameliya, Piliang, Y. K. A., Hidayah, A., & Hasibuan, E. S. H. (2026). Penerapan principal component analysis untuk menentukan faktor-faktor yang mempengaruhi kemiskinan di Sumatera Utara. *Algoritma: Jurnal Matematika, Ilmu Pengetahuan Alam, Kebumian dan Angkasa*, *4*(1), 1–19. https://doi.org/10.62383/algoritma.v4i1.890

Andrestian, M. D., Dewi, Z., Oktiyani, N., & Noraini, N. (2026). Crackers made from nagara bean (*Vigna unguiculata* L.) and three-spot gourami (*Trichopodus trichopterus*) flours as complementary food for stunting prevention. *Indonesian Food Science and Technology Journal*, *9*(2), 231–245. https://doi.org/10.22437/ifstj.v9i2.47896

Asikin, A. N., Diachanty, S., & Rusdi, I. (2024). Physicochemical characteristics of crackers from Kutai Kartanegara SMEs product. *Jurnal Pengolahan Hasil Perikanan Indonesia*, *27*(5), 362–376. https://doi.org/10.17844/jphpi.v27i5.50429

Cheadoloh, R., Meechai, I., & Wei, L. S. (2025). Effect of velvet tamarind (*Dialium cochinchinense* Pierre) residues on properties and structure of mackerel fish crackers. *Philippine Journal of Science*, *154*(1), 57-63. https://doi.org/10.56899/154.01.06

Cozzolino, D., Power, A., & Chapman, J. (2019). Interpreting and reporting principal component analysis in food science analysis and beyond. *Food Analytical Methods*, *12*(11), 2469–2473. https://doi.org/10.1007/s12161-019-01605-5

Guttifera, Rahmawati, L., Sari, S. R., Pratama, F., & Widowati, T. W. (2022). Traditional puffed fish cracker ('kerupuk ikan Palembang') by microwave-oven method: physical properties and microstructure evaluation. *Czech Journal of Food Sciences*, *40*(3). 202-209. https://doi.org/10.17221/52/2021-CJFS

Guttifera, Sari, S. R., Lestari, S., Puteri, R. E., & Wibowo, P. (2023). Pembinaan produk olahan kerupuk kemplang ikan lele dengan microwave pada Pohlaksar Rule Athalla Banyuasin. *Jurnal Abdi Insani*, *10*(1), 135–141. https://doi.org/10.29303/abdiinsani.v10i1.877

Guttifera, Sari, S. R., Pratama, F., Widowati, T. W., & Prariska, D. (2020). Karakteristik sensoris microwaveable kerupuk ikan Palembang dengan perbedaan ketebalan dan level daya pada proses pematangan. *Clarias: Jurnal Perikanan Air Tawar*, *1*(1), 13–18. https://doi.org/10.56869/clarias.v1i1.54

Kartika, T., & Harahap, Z. (2019). The culinary development of pempek as a gastronomic tourist attraction in Palembang Sumatera Selatan. *Tourism Scientific Journal*, *4*(2), 211–233.

Koswara, S., Purba, M., Sulistyorini, D., Aini, A. N., Latifa, Y. K., Yunita, N. A., Wulandari, R., Riani, D., Lustriane, C., Aminah, S., Lastri, N., & Lestari, P. (2017). *Produksi Pangan untuk Industri Rumah Tangga: Kerupuk Kemplang*. Badan Pengawas Obat dan Makanan.

Mukuan, C. V., Pongoh, F. D., & Komalig, H. A. H. (2022). Pengelompokan kecamatan di Kabupaten Minahasa berdasarkan data hasil produksi pertanian tahun 2019 dengan menggunakan analisis komponen utama dan analisis gerombol. *Jurnal Matematika dan Aplikasi*, *11*(1), 12–17. https://ejournal.unsrat.ac.id/v3/index.php/decartesian/article/view/36460

Nisa, F., Astuti, K. D., Maryanih, A., Syafa Taqila, A., Noviyanti, N., & Affanti, C. C. P. (2021). Pemanfaatan limbah cangkang kerang hijau sebagai kerupuk kemplang dalam upaya peningkatan kesejahteraan masyarakat Desa Domas Kecamatan Pontan Provinsi Banten. *Jurnal Abdimas Indonesia*, *1*(2), 103–108. https://doi.org/10.53769/jai.v1i2.96

Nusaibah, Hutabarat, Z., Indra Widianto, D., Abrian, S., Yusman Maulid, D., Pangestika, W., & Arumsari, K. (2021). Proximate and organoleptic analysis of crackers with the addition of tuna fish bone meal (*Thunnus* sp). *Jurnal Agribisnis Perikanan*, *14*(2), 308–315. https://doi.org/10.52046/agrikan.v14i2.308-315

Pratama, R. C., Mulia Jaya, F., & Sari, L. P. (2022). Pengaruh penambahan sari bunga telang (*Clitoria ternatea* Linn) dengan konsentrasi yang berbeda terhadap mutu kerupuk ikan patin. *Jurnal Ilmu-Ilmu Perikanan dan Budidaya Perairan*, *17*(1), 28–38. https://doi.org/10.31851/jipbp.v17i2.7877

Pratiwi, M., & Syarief, A. O. (2024). Analisis komponen utama untuk menentukan faktor prioritas perbaikan jalan di Kota Dumai. *Jurnal Penelitian Inovatif*, *4*(3), 1349–1356. https://doi.org/10.54082/jupin.528

Pristiansyah, Hanafi, F. Y., Amrullah, M. H., Zulfitriyanto, & Hasdiansah. (2023). IPTEK bagi masyarakat mesin pengiris bakal kemplang di Desa Penyamun. *Jurnal Pengabdian Kepada Masyarakat*, *3*(2), 70–77. https://doi.org/10.33504/dulang.v3i02.304

Qamariah, N., Handayani, R., & Mahendra, A. I. (2022). Uji hedonik dan daya simpan sediaan salep ekstrak etanol umbi hati tanah. *Jurnal Surya Medika*, *7*(2), 124–131. https://doi.org/10.33084/jsm.v7i2.3213

Riyananda, C. S., Sarofa, U., & Pratiwi, Y. S. (2026). Sensory attribute profiling and consumer preferences of payus fish (*Elops hawaiensis*) crackers produced by small and medium enterprises in Surabaya city. *Asian Journal of Applied Research for Community Development and Empowerment*, *10*(2), 87–93. https://doi.org/10.29165/ajarcde.v10i2.1026

Septia, A., Haris, H., & Jaya, F. M. (2020). Karakteristik sifat organoleptik kerupuk kemplang dari limbah tulang ikan tenggiri (*Scomberomorus commersoni*) dengan perbandingan yang berbeda. *Jurnal Ilmiah Pangan Halal*, *2*(2), 67–72. https://ojs.unida.info/index.php/JIPH/article/view/4608

Sidharta, A. F., Rachmawati, K., Rimayanti, Utomo, B., Hidajati, N., Santoso, K. P., Sugihartuti, R., & Kurnijasanti, R. (2026). The effect of red ginger (*Zingiber officinale* var. rubrum) extract administration on the number of spermatogenic cells and leydig cells in white rats (*Rattus norvegicus*) exposed to monosodium glutamate. *Journal of Basic Medical Veterinary*, *15*(1), 16–23. https://doi.org/10.20473/jbmv.v15i1.82732

Suyanto, A., Hersoelistyorini, W., Arinachaque, F., Santoso, W. I., & Khamdi, A. (2023). Analisis komponen utama dalam pemetaan karakteristik sensori mi basah tepung beras menir termodifikasi dengan penambahan xanthan gum. *Edible: Jurnal Penelitian Ilmu-Ilmu Teknologi Pangan*, *12*(1), 14–22. https://doi.org/10.32502/jedb.v12i1.7788

Tobing, R. S., Sigalingging, O. H., Sinaga, R. K., & Lubis, R. A. (2026). Penerapan principal component analysis (PCA) untuk reduksi dimensi dan pemetaan karakteristik nutrisi pada produk makanan kemasan di Indonesia. *Algoritma: Jurnal Matematika, Ilmu Pengetahuan Alam, Kebumian dan Angkasa*, *4*(1), 20–30. https://doi.org/10.62383/algoritma.v4i1.891

Widowati, W., & Muzdalifah, L. (2017). Perbandingan analisis biplot klasik dan robust biplot pada pemetaan perguruan tinggi swasta di Jawa Timur. *Jurnal Riset dan Aplikasi Matematika*, *1*(1), 17–26. https://doi.org/10.26740/jram.v1n1.p27-39

Wieldyanisa, E. E., Ismi, F. M., Putri, R. B., Dwitya, S. N., Pusporani, E., & Amelia, D. (2025). Analisis biplot pada berbagai faktor kemiskinan di Indonesia berdasarkan provinsi. *Jurnal Ekonomi Pembangunan*, *7*(2), 71–81. https://doi.org/10.29303/e-jep.v7i2.09