e-ISSN 2581-0405
Asian Journal of Applied Research for Community Development and Empowerment
Journal home page: http://ajarcde-safe-network.org ISSN 2581-0405

# Profilling Sensory of Gluten-Free Almond Crispy from Pedada Fruit Flour and Mocaf Flour with the Addition of Anchovy Flour Using the Rate All That Apply (RATA) Method

*Sofia Balqis Lesmana[1], Jariyah[2], Andre Yusuf Trisna Putra[3], Sri Winarti[4], Hadi Munarko[5]*

[1] *Department of Food Technology, Faculty of Engineering and Science, Universitas Pembangunan Nasional Veteran Jawa Timur, Surabaya, Indonesia.*

**ARTICLE INFO**

*Article History:*
Received: 22 January 2026
Final Revision: 07 February 2026
Accepted: 09 February 2026
Online Publication: 10 February 2026

**KEYWORDS**

*Crispy Almond, Pedada Fruit Flour, Mocaf Flour, Anchovy Flour, Rate-All-That-Apply (RATA)*

**CORRESPONDING AUTHOR**

*E-mail: Jariyah.tp@upnjatim.ac.id

**A B S T R A C T**

Almond crispy is a thin, round cookie characterized by a crunchy texture and a topping of almonds and grated cheese. This study aimed to analyze the sensory profile of almond crispy made from a combination of pedada fruit flour, mocaf flour, and anchovy flour using the Rate All That Apply (RATA) method to identify consumer preferences. Nine formulations were tested with varying ratios of pedada and mocaf flours (5%, 10%, 15%) and different levels of anchovy flour (5%, 10%, 15%). Sensory evaluation involved panelist questionnaires, Focus Group Discussions (FGD), and sensory tests. Data were analyzed using Principal Component Analysis (PCA), preference mapping, and Kruskal-Wallis followed by Dunn's test at a 5% significance level. Results indicated that samples P0T0 and P1T1 were preferred, exhibiting milky and roasted aromas, milky and sweet tastes, crunchy textures, bright colours, and dry mouthfeels. These findings provide insights for optimizing almond crispy formulations based on consumer sensory preferences.

**Contribution to Sustainable Development Goals (SDGs):**
**SDG 2:** Zero Hunger
**SDG 3:** Good Health and Well-Being
**SDG 12**: Responsible Consumption and Production

## 1. INTRODUCTION

### *1.1. Research Background*

Nutritional problems among school-aged children are closely related to inappropriate dietary patterns and limited access to affordable, nutritious foods. The relationship between dietary patterns and children's nutritional status is crucial, as evidenced by studies showing a significant correlation between preschool children's eating patterns, parental knowledge, and children's nutritional status (p-value = 0.038) [1]. One strategy to address this issue is to develop nutritious snack products that align with parental preferences for children while providing high nutritional value, particularly in terms of animal protein, calcium, and iron.

One snack product that has gained popularity is almond crispy, a thin, crunchy biscuit favoured by consumers for its light texture and savoury taste [2]. Almond crispy is a type of thin biscuit enjoyed by various age groups due to its crispy texture and sweet–savory flavor. However, this product is generally made using wheat flour, which contains gluten, making it less suitable for children with gluten intolerance or digestive disorders. An alternative approach is the use of gluten-free flours such as mocaf (modified cassava flour) and pedada fruit flour. The combination of mocaf flour and pedada fruit flour in almond crispy products can enhance nutritional value while also supporting local food diversification [3].

### *1.2. Literature Review*

Indonesia has a wide variety of food resources and culinary variations across its regions. This diversity needs to be continuously developed to generate new innovations in the culinary sector. One such utilization is the processing of food ingredients into snack products, such as almond crispy, an innovative snack that has become increasingly popular among consumers. Almond crispy is a type of cookie derived from *tuile*, a traditional French snack popular since the 1800s [4]. In Indonesia, this product became widely recognised after its development in Surabaya in 2012 [5].

Almond crispy attracts consumers due to its thin, crispy, melt-in-the-mouth texture, its wide variety of flavours (vanilla, chocolate, and green tea), and distinctive toppings of sliced almonds and grated cheese [2]. The main ingredients of almond crispies generally include wheat flour, eggs, sugar, fats (such as margarine or butter), and milk. The processing of almond crispies is relatively simple, involving mixing and baking steps that result in a crispy texture. The product can be stored in airtight containers and consumed over a relatively long period [6]. The production process uses the creaming method, which involves whipping the fat until creamy before mixing it with other ingredients [7], then shaping the batter onto baking trays with a spoon and baking it until crisp.

#### *1.2.1. Pedada fruit flour*

The use of local resources as raw materials for functional foods is being further developed to support national food security. One local ingredient with considerable potential is pedada fruit (Sonneratia caseolaris), a mangrove fruit rich in dietary fibre, antioxidants, and other bioactive compounds. Red pedada fruit has a spiral, round shape with a diameter of approximately 6–8 cm, flat sepals, and a stalked tip; the lower part of the fruit is enclosed by floral sepals. The fruit has a glossy green skin, yellowish flesh, and may contain 800–1,200 seeds [8].

The presence of various bioactive compounds makes the pedada fruit an ideal candidate for processing into value-added functional food products. Pedada fruit flesh has relatively high nutritional content. In 100 g of pedada fruit flesh, it contains 221.97 IU of vitamin A, 5.04 mg of vitamin B1, 7.65 mg of vitamin B2, and 56.74 mg of vitamin C [9].

#### *1.2.2. Anchovhy Flour (Stolephorus sp.)*

Fish is a major animal protein source and is easily processed into various food products. Demand for fish has continued to increase from year to year, particularly as the government promotes national fish consumption. In 2018, fish consumption in Indonesia reached 50.69 kg per capita per year and increased to 54.50 kg per capita per year in 2019. The Ministry of Marine Affairs and Fisheries (KKP) set a target of 62.50 kg of national fish consumption per capita by 2024 [10]. Anchovies live in large schools and are relatively small, ranging from 6–9 cm in length [11].

Anchovy (*Stolephorus* sp.) is a fisheries commodity rich in omega-3 fatty acids, iron, and calcium. Anchovy is well known as a high-value economic fish with excellent nutritional quality. Based on previous studies, 100 g of fresh anchovy contains approximately 77 kcal of energy, 16 g of protein, 1 g of fat, 500 mg of calcium, 1 mg of iron, 500 mg of phosphorus, 47 IU of vitamin A, and 0.1 mg of vitamin B1 [12].

#### *1.2.3. Rate-All-That-Apply (RATA) Method*

Sensory profile characterization is an important aspect in food product development. The objective of this process is to identify the specific sensory attributes of a product so that it can be distinguished from similar products and to determine the resulting sensory quality. One approach that is commonly used in sensory evaluation is consumer-based sensory profiling, which has become increasingly popular because it is more time- and cost-efficient than conventional descriptive methods that rely on trained panelists [13]

One widely applied consumer-based sensory profiling method is Rate-All-That-Apply (RATA). This method extends the Check-All-That-Apply (CATA) method, which originally allowed panellists to select only the sensory attributes they perceived as applicable, without assessing their intensity. A major limitation of CATA is its inability to describe differences in attribute intensity within similar samples, as it produces only binary (yes/no) data. Therefore, the RATA method was developed to allow panelists not only to select attributes but also to rate the perceived intensity of each selected attribute. This enables a more comprehensive and discriminating evaluation of products that share similar attributes but differ in intensity [14].

The RATA method is designed in two stages: a checklist stage and a rating stage. Panellists first select the attributes they perceive in the sample, then assign intensity scores to those attributes. The intensity assessment can use either a 3-point scale (1 = “weak”, 2 = “moderate”, 3 = “strong”) or a 5-point scale (1 = “very weak” to 5 = “very strong”), depending on the research design. The resulting data comprise a combination of binary (presence/absence) and intensity data, thereby providing a more detailed and accurate representation of a product’s sensory profile [15].

## 2. MATERIALS AND METHODS

### *2.1. Materials*

The ingredients used in making crispy almonds are pedada fruit flour, mocaf flour, and anchovy flour. Other supporting ingredients required include butter, powdered sugar, and egg whites. The ingredients used in the sensory evaluation are crispy almonds and 9 different treatments, along with mineral water.

### *2.2. Preparation of Almond Crispy*

The preparation of the almond crispy began with weighing the ingredients. A total of 90 g of flour mixture was used, with different proportions of pedada fruit flour to mocaf flour (5%:95%, 10%:90%, and 15%:85%), combined with anchovy fish flour at 10%, 15%, and 20%. Other ingredients included 50 g of egg white, 50 g of margarine, 63 g of powdered sugar, and 3 g of baking powder. The first mixing step involved creaming the margarine and powdered sugar, then adding the egg white and mixing until the batter was light and fluffy. The flour mixture for each treatment and the baking powder were then added, and the dough was mixed until homogeneous. The batter was shaped into thin circular discs measuring 8 cm in diameter and 0.2 cm thick, then topped with almond slices and grated cheese. Finally, the dough was baked at 110–120 °C for 15–20 minutes.


https://doi.org/10.29165/ajarcde.v10i1.903

### 2.3. Experimental Design and Data Analysis

#### 2.3.1. Product Analysis

Almond crispy products were evaluated using the Rate-All-That-Apply (RATA) method and a hedonic test to determine the selected product.

### 2.4. Analysis Procedure

#### 2.4.1. Questionnaire Distribution

The questionnaire was distributed online to Food Technology students at UPN "Veteran" Jawa Timur who consume almond-crispy products. The panellists were asked to answer several questions, including gender, age, domicile, frequency of cookie consumption, and considerations when purchasing cookies.

#### 2.4.2. Focus Group Discussion (FGD)

The FGD involved 10 selected panelists drawn from the initial questionnaire respondents. The purpose of the FGD was to screen for and identify relevant sensory attributes to include in the sensory evaluation questionnaire. During the FGD, nine almond-crispy product samples were served for tasting, and the panellists described the sensory attributes they perceived.

#### 2.4.3. Rate-All-That-Apply and Hedonic Testing

Sensory evaluation was conducted by 75 untrained or consumer panelists. Each panellist was provided with 9 samples to evaluate at their homes to obtain data that better reflect daily consumption conditions, without direct comparisons among samples. Panelists were also given RATA and hedonic test questionnaires.

In the RATA test, panelists were instructed to check each attribute they perceived in the sample. The sensory attributes comprised five categories: aroma, taste, colour, texture, and mouthfeel. Panellists then rated each sample on a scale from low to high (1–5) to determine its level of similarity to a commercial product. Furthermore, panellists completed the hedonic test questionnaire by providing preference ratings on a 5-point scale ranging from "dislike very much" to "like very much" (1–5).

### 2.5. Data Analysis

RATA intensity data obtained were visualized in spider charts using Microsoft Excel 2019. Panelists' preference data were analyzed using the Kruskal–Wallis test to identify differences among samples for each sensory attribute. When a p-value $\leq 0.05$ was obtained, the analysis was followed by Dunn's post hoc test.

To identify the characteristic features of each sample, Principal Component Analysis (PCA) was performed, and the results were presented as a biplot illustrating the product's sensory profile. Furthermore, consumer preference was determined using Preference Mapping analysis. The results of the preference mapping analysis were presented as an overlay contour plot combined with PCA, with different colours representing the level of panellists' liking.

## 3. RESULT AND DISCUSSION

### 3.1. Results of the Focus Group Discussion (FGD) for the Determination of Sensory Attributes

The FGD participants were 10 individuals selected according to predetermined criteria. The purpose of the FGD was to determine the sensory attributes and their descriptions to be used in the Rate-All-That-Apply (RATA) test. Based on the FGD results, 18 sensory attributes were selected through discussion with trained panelists. These attributes were subsequently used in the RATA evaluation of almond crispy products by untrained panelists, as presented in Table 1.

**Table 1** Attribute Description

| No. | Attribute | Description |
|---|---|---|
| 1 | Milky Aroma | Odor or aroma similar to butter, cheese, or milk |
| 2 | Sour Aroma | Aroma associated with sourness |
| 3 | Fishy Aroma | Aroma associated with the characteristic fishy note of anchovy that gives a savory marine impression |
| 4 | Roasted Aroma | Savory, pleasant aroma typical of baked or roasted foods |
| 5 | Burnt Aroma | Burnt odor caused by excessive baking time |
| 6 | Color Brightness | Indicates whether the color appears bright (light) or dark |
| 7 | Brown Color | The sample appears brown in color |
| 8 | Salty Taste | Salty taste similar to salt or salted fish |
| 9 | Savory Taste | Pleasant savory (umami) taste |
| 10 | Sour Taste | Taste associated with sour fruit |
| 11 | Sweet Taste | Sweet taste derived from granulated or powdered sugar |
| 12 | Fishy Taste | Taste associated with fishiness |
| 13 | Milky Taste | Taste associated with milk |
| 14 | Crispy Texture | Fragile sensation or easy to crumble in the mouth |
| 15 | Gritty Mouthfeel | Gritty sensation in the mouth |
| 16 | Dry Mouthfeel | Gives a dry sensation during consumption |
| 17 | Throat Irritation Mouthfeel | Rough or harsh sensation when swallowing |
| 18 | Bitter Aftertaste | A bitter taste sensation that remains in the mouth after consumption due to excessive baking |

Based on Table 1, several sensory attributes were identified: aroma, colour, taste, texture, mouthfeel, and aftertaste. In general, the sensory characteristics of almond crispy are similar to those of cookies. Reported that nastar cookies possess sensory attributes such as aroma, taste, texture, and mouthfeel [16].

The milky aroma originates from the butter and cheese used in the formulation. According to [17], volatile compounds in butter are formed from evaporated fatty acids, resulting in a milky aroma in the final product. The sour aroma is derived from the use of pedada fruit flour. Stated that pedada fruit has a characteristic sour aroma similar to that of unripe mango [8]. Meanwhile, the fishy aroma results from the addition of anchovy flour, which is associated with nitrogenous compounds such as guanidine, trimethylamine oxide (TMAO), and imidazole derivatives [18]. The roasted aroma is produced during the baking of almond crispy dough at high temperatures, which may also

lead to a burnt aroma due to ongoing Maillard reactions and caramelisation [19].

The brown colour of almond crispy products is produced by the Maillard reaction, which gives foods their characteristic brown colour [20]. This reaction is promoted by the presence of vitamin C in pedada fruit flour, which acts as a reducing agent and accelerates the formation of brown-colored melanoidin pigments at high temperatures. The addition of anchovy flour also affects product colour by denaturing proteins during heating, which contributes to browning reactions [21].

Salty and savory tastes are derived from the glutamic acid content of anchovy flour. Glutamic acid provides a strong, pleasant taste, thereby enhancing overall flavour. Sweet taste originates from the addition of sugar, which acts as a sweetening agent [22]. At high temperatures, sugar undergoes caramelization, producing a characteristic caramel sweetness. In addition, sugar participates in the Maillard reaction, forming complex compounds that contribute to sweet, savory, and roasted flavor notes in the final product [19].

The crispy texture of almond crisp is attributed to retrogradation, a process that occurs during cooling after baking. Retrogradation causes amylose molecules to reassociate with each other and with amylopectin, forming microcrystals that result in a crispy texture [23].

The gritty mouthfeel is caused by using anchovy flour, which can interfere with the caramelisation of sugar, which serves as a binding medium among ingredients. In addition, the high mineral content of anchovy flour can produce a product with a grittier sensation [12]. The addition of pedada flour contributes to gritty and dry mouthfeel as well as throat irritation in almond crispy products. This is due to the coarse fiber content of pedada fruit flour, which can disrupt gluten network formation in the dough, resulting in a denser texture and fine particulate sensations in the mouth. These insoluble fibers also contain hard and sharp particles that may cause irritation in the throat [24].

The bitter aftertaste is associated with the use of anchovy flour, which results from the hydrolysis of the amino acid lysine during baking. Lysine has a more bitter taste compared to other amino acids, which can lead to bitterness in the final product [18].

### *3.2. Determination of Significantly Different Sensory Attributes*

The sensory evaluation data from the RATA test were further analysed using the Kruskal–Wallis test in XLSTAT 2019. The results showed that almond-crispy products had a significant effect on sensory attributes, with a total p-value < 0.05. The significantly different attributes included sour, fishy, and burnt aromas; brown colour; salty, sour, sweet, and fishy tastes; gritty mouthfeel and throat irritation; and a bitter aftertaste, as presented in Table 2.

The results of the Kruskal–Wallis test were further analysed using Dunn's post hoc test at the 5% significance level to identify significant differences among the tested almond crispy samples across sensory attributes, including aroma, colour, taste, texture, mouthfeel, and aftertaste.

**Table 2.** Results of p-value analysis for the sensory attributes of the almond crispy

| No. | Attribute | Sensory attribute profile | p-value |
|---|---|---|---|
| 1 | Aroma | Milky | 0.535 |
| 2 | | **Sour** | **<0.0001** |
| 3 | | **Fishy** | **<0.0001** |
| 4 | | *Roasted* | 0.896 |
| 5 | | ***Burnt*** | **0.033** |
| 6 | Color | **Bright** | **0.000** |
| 7 | | Brown | **<0.0001** |
| 8 | Taste | **Salty** | **<0.0001** |
| 9 | | Umami | 0.697 |
| 10 | | **Sour** | **<0.0001** |
| 11 | | **Sweet** | **0.001** |
| 12 | | **Fishy** | **<0.0001** |
| 13 | | Milky | 0.275 |
| 14 | Texture | Crispy | 0.263 |
| 15 | *Mouthfeel* | Gritty | **0.004** |
| 16 | | Dry | 0.341 |
| 17 | | ***Throat irritation*** | **0.040** |
| 18 | *Aftertaste* | **Bitter** | **0.000** |

**Note:** Values shown in bold indicate significant differences among almond crispy samples for each sensory attribute at a 5% significance level (α = 0.05).

#### *3.2.1. Aroma Attributes*

**Table 3.** Intensity of aroma attributes of almond crispy

| Sample Code | Aroma | | |
|---|---|---|---|
| | **Sour** | **Fishy** | ***Burnt*** |
| P0T0 | $0^{a}$ | $0^{a}$ | $0.28^{a}$ |
| P1T1 | $0.71^{b}$ | $1.19^{bc}$ | $0.76^{a}$ |
| P1T2 | $0.68^{bc}$ | $1.31^{bc}$ | $0.91^{a}$ |
| P1T3 | $1.12^{bcd}$ | $1.85^{c}$ | $0.88^{a}$ |
| P2T1 | $1.27^{bcd}$ | $1.49^{bc}$ | $0.68^{a}$ |
| P2T2 | $1.04^{bcd}$ | $1.12^{bc}$ | $0.52^{a}$ |
| P3T3 | $0.89^{bcd}$ | $1.57^{c}$ | $0.56^{a}$ |
| P3T1 | $1.65^{d}$ | $1.13^{bc}$ | $0.47^{a}$ |
| P3T2 | $1.31^{bcd}$ | $1.05^{b}$ | $0.81^{a}$ |
| P3T3 | $1.48^{cd}$ | $1.73^{c}$ | $0.81^{a}$ |

Aroma is generated by chemical stimuli perceived by the olfactory nerves in the nasal cavity. The results of Dunn's post hoc test showed significant differences in sour, fishy, and burnt aromas among the samples, as presented in Table 3. The highest sour aroma intensity was observed in sample P3T1. This result is attributed to the higher addition of pedada fruit flour, which enhances the sour aroma due to its characteristic acidic note similar to that of unripe mango [8].

The highest intensity of fishy aroma was found in sample P1T3. This is due to the higher proportion of anchovy flour, which intensified the fishy aroma. Heating and processing of anchovy can degrade proteins and produce large amounts of trimethylamine (TMA), resulting in a more dominant fishy aroma [25] [26].

The highest burnt aroma intensity was observed in sample P1T2. The intensity of burnt aroma is influenced by the composition of raw materials and the baking temperature.


https://doi.org/10.29165/ajarcde.v10i1.903

Excessively high temperatures can lead to a burnt aroma due to continuous chemical reactions during baking [19].

### *3.2.2. Color Attributes*

**Table 4.** Intensity of color attributes of almond crispy

| Sample Code | Color | |
|---|---|---|
| | Brightness | Brown |
| P0T0 | 3.31[b] | 2.08[a] |
| P1T1 | 2.44[a] | 3.28[b] |
| P1T2 | 2.92[ab] | 3.04[b] |
| P1T3 | 2.92[ab] | 3.33[b] |
| P2T1 | 2.87[ab] | 3.43[b] |
| P2T2 | 2.64[ab] | 3.24[b] |
| P3T3 | 2.63[ab] | 3.25[b] |
| P3T1 | 2.64[ab] | 3.63[b] |
| P3T2 | 2.57[a] | 3.56[b] |
| P3T3 | 2.37[a] | 3.51[b] |

Colour attributes play an important role in a product's visual appeal, identity, and quality [4]. The results of Dunn's test for color attributes (Table 4) showed that sample P0T0 had the highest brightness, while sample P3T3 exhibited the lowest brightness. This is because using 100% mocaf flour produces a lighter cookie colour, as mocaf flour has a naturally pale yellowish-white base colour.

Dunn's test results for the brown color attribute indicated significant differences among almond crispy samples. Sample P3T1 showed the highest brown colour intensity due to the high addition of pedada fruit flour. The vitamin C content in pedada fruit flour can promote the Maillard reaction during baking. The Maillard reaction involves enzymatically related polymerisation of vitamin C compounds, resulting in the formation of brown pigments [23]. Browning may also occur due to proteins in anchovy flour that denature during baking, thereby contributing to the development of the brown colour [1].

### *3.2.3. Taste Attributes*

Taste is the most important factor in determining whether consumers accept a product. The results of Dunn's post hoc test showed significant differences among taste attributes, as presented in Table 5. The highest salty taste intensity was observed in sample P3T1 due to the use of anchovy flour. The addition of anchovy flour can result in a slightly salty final product [22].

The highest sour taste intensity was also observed in sample P3T1, attributed to the high proportion of pedada fruit flour. Pedada fruit tends to have a characteristic sour taste due to its ascorbic acid content [6]. The highest intensity of sweet taste was observed in sample P1T1. The sweet taste of almond crispy is presumed to come from the addition of powdered sugar as the main sweetener. During baking, sugar decomposes into complex compounds that enhance sweetness through caramelisation [27].

The highest fishy intensity was observed in sample P1T3 due to the higher amount of anchovy flour used. The formation of trimethylamine (TMA), dimethylamine (DMA), and ammonia in anchovy due to enzymatic activity can contribute to fishy aromas and tastes [28].

**Table 5.** Intensity of taste attributes of almond crispy

| Sample Code | Taste | | | |
|---|---|---|---|---|
| | Salty | Sour | Sweet | Fishy |
| P0T0 | 0.99[a] | 0.01[a] | 3[b] | 0.04[a] |
| P1T1 | 1.76[b] | 1.04[b] | 3.04[b] | 1.07[b] |
| P1T2 | 1.93[b] | 0.97[b] | 2.75[ab] | 1.45[b] |
| P1T3 | 2.16[b] | 1.08[b] | 2.48[ab] | 1.72[b] |
| P2T1 | 1.95[b] | 1.4[bc] | 2.84[ab] | 1.31[b] |
| P2T2 | 1.71[ab] | 1.21[bc] | 2.6[ab] | 1.25[b] |
| P3T3 | 2.08[b] | 1.31[bc] | 2.51[ab] | 1.63[b] |
| P3T1 | 2.25[b] | 1.91[c] | 2.64[ab] | 1.17[b] |
| P3T2 | 1.88[b] | 1.47[bc] | 2.36[a] | 1.24[b] |
| P3T3 | 2.05[b] | 1.88[c] | 2.48[ab] | 1.69[b] |

### *3.2.4. Mouthfeel and Aftertaste Attributes*

Mouthfeel is a complex sensory perception involving physical, tactile, and textural sensations experienced in the mouth during food consumption [3]. Aftertaste refers to the sensation of taste and aroma that remains in the mouth after consuming a product [29]. The results of Dunn's post hoc test showed significant differences in mouthfeel and aftertaste attributes among the samples, as presented in Table 7.

The highest intensity of gritty mouthfeel was observed in sample P3T1. A higher addition of pedada flour increases the fiber content of almond crispy products. Raw materials with high crude fibre content can impart a gritty texture to baked products. Coarse fibre can disrupt gluten network formation, resulting in a denser texture and a fine particulate sensation in the mouth [11] [30].

**Table 6.** Intensity of mouthfeel and aftertaste attributes of the almond crispy

| Sample Code | *Mouthfeel* Gritty | *Mouthfeel Throat Irritation* | *Aftertaste* Bitter |
|---|---|---|---|
| P1T1 | 1.49[ab] | 1.05[ab] | 0.67[ab] |
| P1T2 | 1.52[ab] | 1.13[ab] | 1.03[b] |
| P1T3 | 1.65[ab] | 1.23[ab] | 1.13[b] |
| P2T1 | 1.63[ab] | 1.44[b] | 0.81[b] |
| P2T2 | 1.44[ab] | 1.41[ab] | 0.88[ab] |
| P3T3 | 1.64[ab] | 1.25[ab] | 1.03b |
| P3T1 | 2.08[b] | 1.44[ab] | 0.83[ab] |
| P3T2 | 1.77[ab] | 1.21[ab] | 0.87[b] |
| P3T3 | 1.83[b] | 1.43[ab] | 0.97[b] |
| P0T0 | 1.03[a] | 0.67[a] | 0.16[a] |

The highest intensity of throat irritation mouthfeel was found in samples P2T1 and P3T1. Throat irritation mouthfeel was directly proportional to the gritty mouthfeel observed in the samples. The coarse fibre in almond crispy products contains hard, sharp particles that can rub against the oral cavity and throat walls, causing irritation or dryness. The highest bitterness aftertaste was observed in sample P1T3 due to the higher amount of anchovy flour used. Anchovies contain lysine, one of the most bitter-tasting amino acids. Bitterness arises from the hydrolysis of

amino acids occurring during the Maillard reaction in processing [26].

### 3.3. *Principal Component Analysis (PCA)*

Principal Component Analysis (PCA) was performed to reduce the complexity of the sensory data and to visualise relationships between sensory attributes and almond crispy formulations.

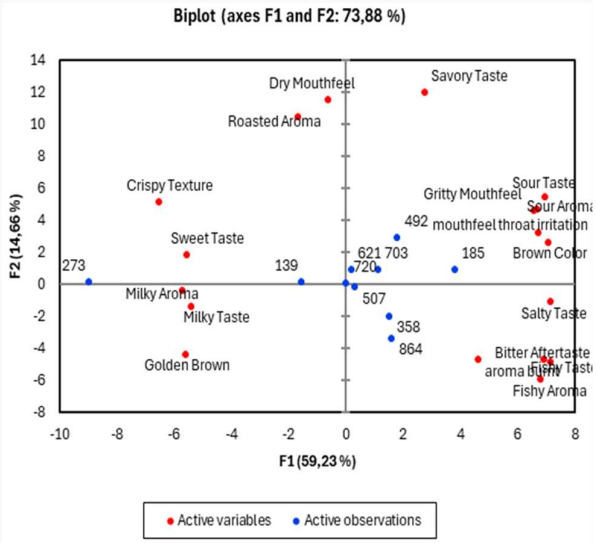


**Fig 1.** The PCA biplot

Based on the Principal Component Analysis (PCA) biplot, the first principal component (F1) and the second principal component (F2) explained variation in sensory characteristics among almond crispy samples, with most of the variation explained by the F1 dimension. Samples P3T1, P3T2, and P3T3, which are located in Quadrant I (upper right), were characterized by the dominance of savory taste, sour taste and aroma, brown color, as well as gritty mouthfeel and throat irritation. These characteristics indicate the strong influence of the combination of anchovy flour and pedada flour on the development of an intense savory–sour flavor profile, accompanied by less desirable physical sensations due to the high fiber and protein content (Figure 1).

Samples P0T0 and P1T1 were positioned close to each other on the left side of the biplot (negative F1 direction), indicating similar sensory characteristics dominated by sweet taste, milky taste and aroma, and crispy texture. The use of pedada fruit flour and anchovy flour in sample P1T1 positioned it slightly closer to the centre of the plot, suggesting a tendency toward roasted aroma and a dry mouthfeel. Sample P1T1 also exhibited sensory attributes similar to those of P0T0, but with lower intensity.

Based on the PCA biplot results, samples P3T2, P2T2, P2T1, and P1T2, which were located near the origin, exhibited more moderate and balanced sensory characteristics compared to the other samples. Meanwhile, samples P2T3 and P1T3 were located in Quadrant IV (lower right), indicating similar sensory characteristics marked by the dominance of burnt aroma, fishy aroma, salty taste, and bitter mouthfeel. The direction of the vectors in Quadrant IV indicates a tendency toward undesirable attributes, likely due to proteins and lipids from anchovy flour undergoing chemical changes during the baking process.

### 3.4. *Panellists' Preference Mapping*

Preference Mapping is a technique used to identify sensory samples preferred by consumers, based on cluster analysis derived from Agglomerative Hierarchical Clustering (AHC) of hedonic data and principal component analysis (PCA) of the PCA results. Based on Figure 2, samples P3T3, P3T2, P3T1, and P2T1 were in the low-preference region (20–40%), indicating that panellists preferred the sensory characteristics of these formulations less. The dominant attributes in this region included sour taste and aroma, gritty mouthfeel, throat irritation, and brown colour, which were less preferred by panellists.

Samples P2T3, P1T3, P2T2, and P1T2 were in the medium preference region (40–60%), indicating that the sensory characteristics of these formulations were still acceptable, although they were not the primary choice of panelists. The dominant attributes in this region included salty, fishy, burnt, and bitter aftertaste.

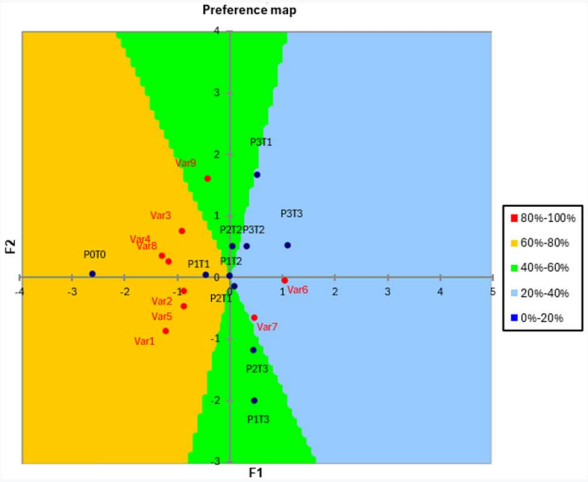


**Fig 2.** Panelists' preference map for almond crispy

The high-preference region (60–80%) was dominated by samples P0T0 and P1T1, which elicited the highest levels of panellists' liking. The dominant attributes in this region included a crispy texture, a sweet taste, a milky aroma and taste, and a bright colour. These results indicate that panellists preferred almond-crispy products with a sweet, crispy texture, suggesting greater potential for further development and consumer acceptance.

### 3.5. *Panelists' Liking Level toward Almond Crispy*

The level of panellists' liking for 10 almond-crispy samples was measured using a hedonic rating test with a 6-point preference scale. Based on Table 7, sample P0T0 exhibited the highest level of liking, while sample P3T3 showed the lowest. This indicates that almond crispy made with 100% mocaf flour was preferred by consumers because it possessed sensory attributes similar to those of commercial products, whereas sample P3T3 reduced panellists' liking due to increasingly strong sour and fishy tastes.

Nevertheless, samples P1T1 and P2T1 showed relatively high liking scores and were not significantly different from P0T0. This suggests that the use of pedada flour and anchovy flour at moderate concentrations remains acceptable to panellists and has


https://doi.org/10.29165/ajarcde.v10i1.903

the potential to serve as an alternative formulation to enhance nutritional value without reducing overall product acceptability.

**Table 7.** Liking level of almond crispy products

| Sample | Overall |
|---|---|
| P3T3 | $3.87^{a}$ |
| P3T2 | $4.33^{bc}$ |
| P3T1 | $4.37^{bc}$ |
| P2T3 | $4.41^{bcd}$ |
| P2T2 | $4.47^{bcd}$ |
| P2T1 | $4.56^{bcd}$ |
| P1T3 | $4.25^{ab}$ |
| P1T2 | $4.44^{bcd}$ |
| P1T1 | $4.79^{cd}$ |
| P0T0 | $4.80^{d}$ |

## 4. CONCLUSION

Sensory profile analysis of almond crispy using the Rate-All-That-Apply method combined with Principal Component Analysis (PCA) showed that formulations with high substitution levels of pedada flour and anchovy flour exhibited less preferred sensory attributes, such as sour taste and aroma, fishy aroma, gritty mouthfeel, and brown colour. In contrast, samples P0T0 and P1T1 exhibited the most preferred sensory profiles, characterised by milky and roasted aromas, a sweet taste, a crispy texture, a bright colour, and a dry mouthfeel. The preference mapping results further confirmed that these two samples were in the highest preference level (60–80%). Therefore, it can be concluded that the sweet, crispy, and milky aromatic characteristics represent the most desirable sensory profile of almond crispy, according to panellists.

**REFERENCE**


[1] Fatmawati, I., Marjan, A. Q., Wahyudi, C. T., Jadmiko, A. W., & Arini, F. A. (2024). Edukasi PHBS Rumah Tangga, Pengukuran Status Gizi dan Tekanan Darah diKampung Pemulung Pondok Kelapa Jakarta Timur. Jurnal Kreativitas Pengabdian Kepada Masyarakat (PKM), 7(1).

[2] Wisudawanningrum, D.A.P.P., dan Pangesthi, L.T. (2019). Pengaruh Proporsi Puree Gatot Instan dan Jenis Shortening Terhadap Sifat Organoleptik Donat. Jurnal Tata Boga. Vol 8(1) : 144-153.

[3] Wolinska-Kennard, K., Schönberger, C., Fenton, A., & Sahin, A. W. (2025). Mouthfeel of Food and Beverages: A Comprehensive Review of Physiology, Biochemistry, and Key Sensory Compounds. Comprehensive reviews in food science and food safety, 24(4), e70223.

[4] Tarwendah, I. P. (2017). Jumal Review: Studi Komparasi Atribut Sensori & Kesadaran Merek Produk Pangan. Jurnal Pangan & Agroindustri, 5(2), 66- 73.

[5] Kusuma, A., Nugroho, S.D. & Parsudi, S. 2017. Selera Konsumen Dalam Pembelian'Almond Crispy" Di Toko Wisata Rasa Jemursari Surabaya. Berkala Ilmiah Agribisnis AGRIDEVINA, 6(1),13-26

[6] Iftitah, K., Saputra, E., & Pujiastuti, D. Y. (2025). Karakteristik dan masa simpan *fruit leather* berbahan baku buah pedada (*Sonneratia caseolaris*) dengan penambahan sorbitol dan *Kappaphycus alvarezii* (*Characteristics and shelf life of pedada fruit leather with the addition of sorbitol and Kappaphycus alvarezii*). *Journal of Marine and Coastal Science (JMCS), 14*(1).

[7] Gisslen, W. (2013). Professional Baking Sixth Edition. Canada: Published by John Wiley & Sons, Inc., Hoboken, New Jersey.

[8] Alharanu, P. R., & Eviana, N. (2020). Pemanfaatan buah pedada (Sonneratia caseolaris) pada pembuatan permen jelly. Jurnal Eduturisma, 4(2), 1–12.

[9] Manalu, R. D. E. 2011. Kadar beberapa vitamin pada buah Pedada (Sonneratia caseolaris) dan hasil olahannya. Skripsi Departemen Teknologi Hasil Perairan Fakultas Perairan dan Ilmu Kelautan Institut Pertanian Bogor. Bogor.

[10] [TKPI] TKPI. (2020). Tabel Komposisi Pangan Indonesia. Jakarta: Kementerian Kesehatan RI.

[11] Wang, H., Li, A., Kong, L., & Zhang, X. (2021). Effect of Zn-rich wheat bran with different particle sizes on the quality of steamed bread. *Frontiers in Nutrition, 8*, 761708.

[12] Kamudung, O., Tega, Y. R., & Henggu, K. U. (2023). Karakteristik kandungan mutuikanasinkering teri (stolephorus sp.) Di pasar matawai kabupatensumbatimur. Proceeding Sustainable Agricultural Technology Innovation (SATI), 2(1), 1–6.

[13] Fibrianto, K., & Dwihindarti, M. 2017. Profiling Atribut Jamu Kunyit Asam Dan Jamu Sinom Dengan Metode Rata (Rate-All-That-Apply) Pada Beberapa Kota Di Jawa Timur (Profiling Attribute Of Jamu Kunyit Asam And Sinom By Rata (Rate-All-That-Apply) At Several Cities In East Java). Jurnal Teknologi Pangan, 10(1).

[14] Ares, G., Bruzzone, F., Vidal, L., Cadena, R. S., Giménez, A., Pineau, B., Hunter, D. C., Paisley, A. G., & Jaeger, S. R. (2014). Evaluation of a rating-based variant of check-all-that-apply questions: Rate-All-That-Apply (RATA). Food Quality and Preference, 36, 87–95.

[15] Meyners, M., Jaeger, S. R., & Ares, G. (2016). On the analysis of Rate-All-That Apply (RATA) Food Quality and Preference, 49(2016), 1–10.

[16] Munarko, H., Jariyah, Kurnianto, M.H. (2023). *Profiling* Atribut Sensori Kukis Nastar Menggunakan Metode *Rate-All-That-Apply* (RATA). Gorontalo Agriculture Technology Journal. Vol 6(2).

[17] Widodo, A. (2023). Pengembangan Mocaf (Modified cassava flour) Berbasis Desa Mandiri Mocaf: Studi Kasus Kabupaten Banjarnegara. Bappenas Working Papers. Vol. 6 No. 1.

[18] Soechan, Lanny. (2016). *Crispy* Cookies (Indonesian Edition). Jakarta: Gramedia Pustaka Utama.

[19] Haryani, Kristinah., Hargono., Handayani, N.A., Ramadani, P., & Rezekia, Dikie. 2017.Substitusi Terigu dengan Pati Sorgum Terfermentasi pada Pembuatan Roti Tawar: Studi Suhu Pemanggangan. Jurnal Aplikasi Teknologi Pangan. 6 (9).

[20] El Hosry, L., Elias, V., Chamoun, V., Halawi, M., Cayot, P., Nehme, A., & Bou-Maroun, E. (2025). Maillard Reaction: Mechanism, Influencing Parameters, Advantages, Disadvantages, and Food Industrial Applications: A Review. *Foods*, *14*(11), 1881

[21] Haq, A. D., Ratnaningsih, N., & Lastariwati, B. (2021). Substitusi tepung ikan teri (Stolephorus sp.) dalam pembuatan kue semprong sebagai sumber kalsium untuk anak sekolah. Jurnal Pengolahan Hasil Perikanan Indonesia, 24(3), 264- 273.

[22] Istifada, D. S., Swastawati, F., & Wijayanti, I. (2023). Pengaruh penambahan tepung ikan teri hitam (*Stolephorus insularis*) terhadap karakteristik kimia dan tekstur pizza base. *Jurnal Pengolahan Hasil Perikanan Indonesia (JPHPI), 26*(2).

[23] Damayanti, S., Bintoro, V. P., & Setiani, B. E. (2020). Pengaruh penambahan tepung komposit terigu, bekatul,

dan kacang merah terhadap sifat fisik *cookies*. *Journal of Nutrition College, 9*(3), 180–186.

[24] Wicaksono, W. dan Handayani, I. 2023. Pembuatan Almond *Crispy* Tepung Mocaf Dengan Taburan Biji Ketapang. Jurnal Ipteks Tata Boga, Tata Rias dan Tata Busana, Vol. 15(1).

[25] Pratama, R. I., Rostiana, I., & Rochima, E. (2018). Profil asam amino, asam lemak dan komponen volatil ikan gurame segar (*Osphronemus gouramy*) dan kukus. *Jurnal Pengolahan Hasil Perikanan Indonesia, 21*(2), 218–231.

[26] Ramadhan, R., Nuryanto, N., & Wijayanti, H. S. (2019). Kandungan gizi dan daya terima cookies berbasis tepung ikan teri (*Stolephorus* sp) sebagai PMT-P untuk balita gizi kurang. *Journal of Nutrition College, 8*(4), 264–273

[27] Mangumbas, E. P., Tuju, T. D., & Sumual, M. F. (2021). Pengaruh lama perendaman buah salak (*Salacca edulis* Reinw) dalam larutan kapur sirih terhadap sifat sensoris manisan kering. *Jurnal Teknologi Pertanian (Agricultural Technology Journal), 12*(1), 37–43.

[28] Hasanah, F., Lestari, N., & Adiningsih, Y. (2017). Pengendalian senyawa trimetilamin (TMA) dan amonia dalam pembuatan margarin dari minyak patin. *Warta IHP, 34*(2), 72–80.

[29] Yusianto, R., & Ismayadi, I. (2016). Pengaruh aftertaste terhadap penerimaan konsumen pada produk makanan. Jurnal Teknologi dan Industri Pangan, 27(3), 230–237.

[30] Kurek, M., Wyrwisz, J., Piwińska, M., & Wierzbicka, A. (2016). The effect of oat fibre powder particle size on the physical properties of wheat bread rolls. *Food Technology and Biotechnology, 54*(1), 45–51.

 https://doi.org/10.29165/ajarcde.v10i1.903