# Assessment of Pliek-U Sensory Attributes: A Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) Method Application

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**ABSTRACT**

Sensory assessment plays an important role in solving the problem of consumer preferences and acceptance of food products. This study aims to conduct a Pliek-U sensory assessment through a multi-criteria decision-making system using the Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) method. MOORA is a multi-objective system that has a good level of selectivity in determining an alternative. There were 7 commercial Pliek-Us obtained from the local Aceh market (P1, P2, P3, P4, P5, P6 and P7). The sensory criteria assessment of commercial Pliek-U included color (C1), aroma (C2), taste (C3), texture (C4), aftertaste (C5), defects (C6), and overall acceptance (C7), which used a hedonic scale (1-7). These 7 sensory attributes are able to describe the expected quality of Pliek-U products and are often used as indicators to assess the sensory properties of food products in Indonesia. Sensory assessment was carried out by 50 panelists from Pliek U consumers. The findings of this study each commercial Pliek-U product used had its own characteristics affecting preference of the panelists. The Pliek-U product (P4) obtained the highest score with a value of 0.390 (rank 1). The characteristics are that it has a distinctive odor from Pliek-U, dark brown in color, having an acid taste favored by panelists, having a dry texture, no taste remains in the mouth, and no other taste which appeared when Pliek-U was eaten. Based on overall acceptance, this Pliek-U was highly preferred. Overall, the results of this study indicate that sensory assessment is very important to assess the attributes or quality of Pliek-U.

## 1. INTRODUCTION

Coconut (*Cocos nucifera* L.) is the most common cultivated plantation commodity in Indonesia, especially in Aceh Province. Usually, Aceh people process coconut flesh into three derivative products, namely pliek oil, simplah oil, and Pliek-U [1]. The Pliek-U production process consists of fermentation, drying, and pressing processes [2]. The production systems have a significant impact on the quality Pliek-U [3]. Fermentation possesses several benefits, including extending the shelf life of food by inhibiting the growth of microorganisms [4]. The drying and pressing process is carried out to reduce the moisture content of Pliek-U. Moisture content also determines the quality of Pliek-U samples. Water content is a parameter that affects the level of resistance of Pliek-U to damage due to high water content can cause by fungal and mold infections [1] The dregs produced from the pressing stage are called Pliek-U, which is often used as a spice for typical Acehnese dishes with a distinctive taste [5].

Currently, Pliek-U has been sold in traditional markets, souvenir shops, and supermarkets. It has a label on the packaging. Pliek-U circulating in the Aceh area have different colors, aromas, and tastes. The varying quality of Pliek-U is also influenced by differences in production systems [3]. So far, Pliek-U products that have been commercialized have not been evaluated sensorily, so consumers feel uncomfortable when buying this product. Sensory properties are important quality parameters because these assessments determine the acceptance of a product by consumers, in addition to the nutritional and functional aspects of the product. Sensory trait analysis is performed to evaluate processes on a production line, inspect final products, or develop new products [6].

Product development must be consumer-oriented to meet consumer needs based on consumer preferences, values and goals [7]. The perception of consumers who want Pliek-U with certain sensory criteria must be considered by Pliek-U producers because it can increase sales and the economics of the Pliek-U industry. Pliek-U will have high value if it has been evaluated sensorially because consumers will have more trust and confidence when buying Pliek-U.

Sensory analysis can be defined as an interdisciplinary field that describes the description, measurement, and interpretation of the characteristics of a product, which can be perceived by the human senses [8]. Several methods that can be used by the authors to assess organoleptic are hedonic test or preference

test. Assessment of consumer acceptance of food products is carried out through sensory assessment by collecting opinions from panelists regarding the products presented. In this case, the authors carried out an analysis of sensory assessment of commercial Pliek-U products acceptance using the Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) method. Sensory assessment with the MOORA method can be a model of solving problems in the acceptance of Pliek-U decisions as quality traditional food [9]. It has simple mathematical calculations and is easy to implement. Furthermore, the results obtained are also more accurate and targeted in helping decision-making [9].

## 2. MATERIALS AND METHODS

The commercial Pliek-U used was Aceh's Pliek-U, which came from 7 (seven) different home industries and had been commercialized in traditional markets, souvenir shops and supermarkets in Aceh Besar, and Banda Aceh. The stages carried out in this study consisted of the preparation of commercial Pliek-U samples, sensory analysis by consumer panelists, and decision making using the MOORA method.

### 2.1 Preparation of commercial Pliek-U samples

The sampling technique used in this study was a purposive sampling technique, which was a method of determining the sample/data that was determined intentionally on the basis of certain criteria or considerations [10]. The criteria or considerations for commercial Pliek-U were Pliek-U which had been packaged in bottles, plastic packaging and labeled packaging. These criteria are able to represents the research sample selection. Each sample was assigned by a code, namely P1, P2, P3, P4, P5, P6, and P7 (Figure 1).
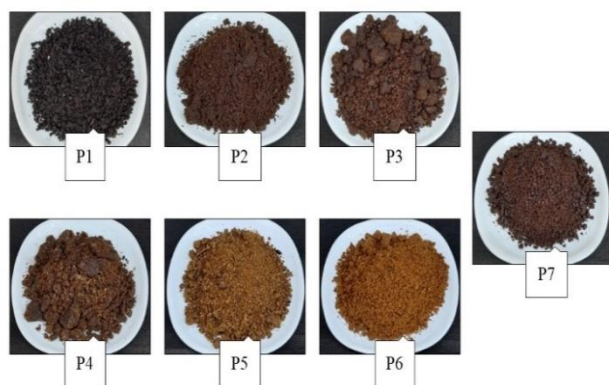


**Figure 1.** Commercial Pliek-U

### 2.2 Panelist

A total of 50 (fifty) consumers acted as panelists who conducted a multi-sensory criteria assessment of the commercial Pliek-U. This assessment was conducted to determine the extent of consumer acceptance of the commercial Pliek-U [10]. At the initial stage, the panelists filled out self-data questionnaires to collect background information, namely gender and age. Before the sensory assessment was carried out, a brief explanation was given to the panelists to ensure that the panelists understood the assessment process that would be carried out. The selected panelists consisted of 30 women and 20 men, with an age interval of 23-50 years. That age is considered to be a productive period in which one is seen as capable of making decisions to choose the best alternatives. Moreover, a person's abilities to feel, smell, hear, and see generally decline as they age.

Panelists evaluated the taste of Pliek-U by filling out the questionnaire given for each commercial Pliek-U product and giving a hedonic assessment of the product. The hedonic test was the most widely used test to measure the level of preference for the product. This level of preference is referred to as the hedonic scale [11]. Selection of panelists used a number of criteria [12], namely:
a) They liked Pliek-U, whether eaten raw or processed;
b) They could distinguish salty, sour, sweet and savory tastes;
c) They were not in a state of illness (such as cough, flu, canker sores and so on) which could interfere with the process of sensory testing for Pliek-U;
d) They were not color blind.

### 2.3 Determination of Pliek-U's multi-criteria assessment

Sensory multi-criteria assessment included color (C1), aroma (C2), taste (C3), texture (C4), aftertaste (C5), defects (C6), and overall acceptance (C7). Sensory assessments utilizing of human senses and the most influential judgments on the acceptance of a product based on the decisions of panellists [12].

The detailed explanation of each of these criteria is found in Table 1.

**Table 1.** Weighting of commercial Pliek-U criteria

| Attribute | Explanation | Weight |
|---|---|---|
| Color (C1) | Dark Chocolate | |
| Aroma (C2) | It was not rancid and has a characteristic Pliek-U smell when inhaled | |
| Taste (C3) | Sour | |
| Texture (C4) | Dry and not watery | |
| Defect (C5) | Other flavors that appeared besides the original Pliek-U taste when swallowed | |
| Aftertaste(C6) | A sensation in the mouth emanating from the back of the palate after Pliek-U was swallowed. | |
| Overall Acceptance (C7) | Distinctive aroma, dark brown in color, dry, not rancid and had a delicious sour taste | |
| **Total Weight** | | **100%** |

Interest weighting was carried out before presenting product samples based on the definition of each criterion and the panelists' knowledge of Pliek-U products. The importance weight value is determined based on the percentage value of the amount of each criterion. Therefore, results play an important role in decision making using the MOORA method [9].

### 2.4 Consumer preferences for Pliek-U's sensory ratings

Panelists were given a commercial Pliek-U sample, where the panelists identified predetermined criteria. Panelists' assessment of the multi-criteria considered in the sensory assessment used a hedonic scale, namely the preferences or

opinions of the panelists based on likes and dislikes which were converted into numbers. Higher score indicates better quality attributes [13, 14]. A sample is considered liked by the panelists if it gets a score of more than 4 [15]. Panelists were instructed to rinse the palate using water between each sample to prevent bias [16]. The results of the commercial Pliek-U assessment preferences are revealed in Table 2.

**Table 2.** The preference of the assessment is based on the level of hedonic scale

| Value | Preferences |
|-------|-------------|
| 7 | Like Very Much |
| 6 | Like Moderately |
| 5 | Like Slightly |
| 4 | Neither Like Nor Dislike |
| 3 | Dislike Slightly |
| 2 | Dislike Moderately |
| 1 | Dislike Very Much |

## 2.5 Sensory testing of commercial Pliek-U's using MOORA

MOORA is a method of multi-purpose decision-making concerning optimizing two or more conflicting attributes simultaneously [17-19]. Furthermore, it is very useful for solving very complex problems. The mechanism is to weigh each specific criterion. Later, the value of the assessment weight of each alternative will be generated.

Here are the steps used in completing MOORA [20]:

(1) Creating a MOORA decision matrix

$$X = \begin{vmatrix} x_{ij} & x_{ij} & x_{ij} \\ x_{ij} & x_{ij} & x_{ij} \\ x_{ij} & x_{ij} & x_{ij} \end{vmatrix} \qquad (1)$$

where, $x_{ij}$= alternative response $j$ on criterion $i$, $i$=1, 2, 3, 4, ..., n is the sequence number of the attribute or criteria, $j$=1, 2, 3, 4, ..., m is the alternate sequence number, $X$=decision matrix.

(2) Determining MOORA normalization matrix

This ratio can be expressed as follows:

$$X_{ij}^* = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{m} X_{ij}^2}} \qquad (2)$$

where, $X_{ij}^*$ = Alternate Normalization Matrix $j$ on criteria $i$.

(3) Calculating the value of MOORA multi-objective optimization

$$Yi = \sum_{j=1}^{g} X^*ij - \sum_{j=g+1}^{n} X^*ij \qquad (3)$$

where, $g$=number of attributes to be maximized, $n$-$g$=number of attributes to be minimized, $Yi$=the normal value of the alternate value of all attributes.

The attributes or criteria on each of the alternatives (commercial Pliek-U) are given a weight value of importance. The weight value is given to the criterion against (color, aroma, taste, texture, after taste, defect, and overall acceptance), provided that the maximum criterion weight value is more significant than the minimum criteria weight value. To signify that an attribute is crucial, it can be multiplied by the corresponding weight [21].

$$Y_i = \sum_{j=1}^{n} W_j X_{ij}^* - \sum_{j=g+1}^{n} W_j X_{ij}^* \qquad (4)$$

where, $W_j$=attribute weight against $j^{th}$, $Y_i$=the normalized valuation value of the 1st alternative attribute.

(4) Determining the Ranking Value from the MOORA calculation results

The value of $Y_i$ could be negative or positive. It depends on the total maximum (for profitable commercial Pliek-U) and minimum (for unprofitable commercial Pliek-U) in decision matrix. An ordered rank of $Y_i$ indicated the last choice. Therefore, the best commercial Pliek-U alternative had the highest value of $Y_i$, whereas the worst commercial Pliek-U alternative had the lowest value of $Y_i$.

## 3. RESULTS AND DISCUSSION

### 3.1 Weight of interest

The priority is obtained from the assessment of consumer panelists, including the criteria for aroma, color, taste, texture, aftertaste, defect, and overall acceptance. The weighting value determines the criterion's magnitude. Therefore, the results of weighting in decision making using the MOORA method are very crucial, where the multiplication of the normalized matrix with the weight of the criteria will affect the ranking of alternatives [22]. The MOORA method is flexible, easy-to-understand, and objective method. The MOORA method is also selective because the method can determine criteria and conflicting goals, namely beneficial or unfavourable (cost) criteria [23]. The calculation results can be seen in Table 3.

**Table 3.** Weight of commercial Pliek-U criteria using MOORA method assessment ($Wj$)

| Criteria | Weight ($Wj$) | Information |
|----------|---------------|-------------|
| Color (C1) | 0.164 | Benefit |
| Aroma (C2) | 0.172 | Benefit |
| Taste (C3) | 0.230 | Benefit |
| Texture (C4) | 0.117 | Benefit |
| Aftertaste (C6) | 0.095 | Benefit |
| Defect (C5) | 0.069 | Cost |
| Overall Acceptance (C7) | 0.154 | Benefit |

The weight of the criteria was assessed based on the panellists' knowledge about the taste of Pliek-U. The weighting of the criteria aimed to determine how much importance each parameter was used in assessing taste (Table 3). The weighting of the criteria had been carried out before the product was served. They were based on the understanding and knowledge of the panelists [24].

Taste criterion got the highest score of 0.230 (23%). Therefore, taste was very important in consumer acceptance of Pliek-U. Taste is crucial criteria influencing consumers' final decisions in accepting or rejecting a product [12]. Furthermore, the criterion that was in the second position was aroma, with a value of 0.172 (17.2%). Aroma was important because if it smelled bad, then Pliek-U was not suitable for consumption. Aroma is an odor triggered by chemical stimuli smelled by the olfactory nerves in the nasal cavity [25]. The aroma of food can trigger the stimulation of the sense of smell, thereby increasing the attractiveness and taste of the food [24].

The next criterion was color, with a value of 0.164 (16.4%). Color was the first one which is seen directly by the panelists. Color can influence taste, supporting sensory acceptance of the product [26]. Food ingredients quality generally depends on the color. Originality of color will give an impression in the panelist's assessment [25, 27]. The criterion that was in fourth place with a value of 0.154 (15.4%) was overall acceptance. Overall acceptance is very important because this criterion becomes the benchmark in determining the quality of commercial Pliek-U.

The texture criterion was fifth position, with a value of 0.117 (11.7%). Texture is an important criterion in assessing taste by the human senses. Pliek-U texture should be dry and not runny when touched. The aftertaste criterion was the sixth criterion with a value of 0.095 (9.5%). Aftertaste was considered important in the process of tasting a product, where if a product had a bad aftertaste, then the product would not be liked by consumers. The last criterion was defect, with a value of 0.069 (6.9%). Pliek-U which has a defect is not good for consumption.

## 3.2 The value of the commercial Pliek-U criteria on each alternative

The assessment results of commercial Pliek-U by 50 panelists are shown in Table 4. From Table 4 it can be seen that the preference level of the 50 (fifty) consumer panelists on the commercial Pliek-U taste criteria was different for each alternative, this caused difficulties in making a decision on the best commercial Pliek-U among the 7 (seven) alternatives. Therefore, a decision-making method is needed to determine which alternative is most acceptable to consumers.

## 3.3 Decision matrix of commercial Pliek-U ($X_{ij}$)

After obtaining the alternative results of commercial Pliek-U from each criterion, the next step was to make a matrix of commercial Pliek-U decisions which can be seen below:

$$X_{ij} = \begin{Bmatrix} 4.193 & 4.367 & 3.793 & 5.373 & 3.913 & 3.867 & 3.893 \\ 5.087 & 4.700 & 4.140 & 5.147 & 4.260 & 4.100 & 4.907 \\ 5.487 & 5.320 & 5.440 & 4.880 & 4.687 & 4.033 & 5.760 \\ 5.393 & 5.807 & 5.960 & 4.840 & 5.560 & 5.460 & 5.733 \\ 4.667 & 4.300 & 4.340 & 4.640 & 4.453 & 4.587 & 5.013 \\ 4.220 & 4.227 & 3.793 & 3.973 & 4.280 & 3.987 & 4.013 \\ 4.593 & 3.940 & 3.607 & 3.693 & 3.820 & 3.720 & 3.707 \end{Bmatrix}$$

## 3.4 Decision matrix normalization

After obtaining the commercial Pliek-U decision matrix, then the matrix normalization was carried out which aimed to unite each element of matrix, so that they had uniform values. Matrix normalization used Eq. (2). The results are demonstrated in Table 5. This is an important step of the MOORA method because it determines the final result in the form of the best alternative [28].

**Table 4.** Recapitulation of commercial Pliek-U's alternative assessments on each criterion of the MOORA method

| Alternative | Criteria | | | | | | |
|---|---|---|---|---|---|---|---|
| | Aroma C1 | Color C2 | Taste C3 | Texture C4 | Aftertaste C5 | Defect C6 | Overall Acceptance C7 |
| P1 | 4.193 | 4.367 | 3.793 | 5.373 | 3.913 | 3.867 | 3.893 |
| P2 | 5.087 | 4.700 | 4.140 | 5.147 | 4.260 | 4.100 | 4.907 |
| P3 | 5.487 | 5.320 | 5.440 | 4.880 | 4.687 | 4.033 | 5.760 |
| P4 | 5.393 | 5.807 | 5.960 | 4.840 | 5.560 | 5.460 | 5.733 |
| P5 | 4.667 | 4.300 | 4.340 | 4.640 | 4.453 | 4.587 | 5.013 |
| P6 | 4.220 | 4.227 | 3.793 | 3.973 | 4.280 | 3.987 | 4.013 |
| P7 | 4.593 | 3.940 | 3.607 | 3.693 | 3.820 | 3.720 | 3.707 |

**Table 5.** Decision matrix normalization results

| Alternative | Criteria | | | | | | |
|---|---|---|---|---|---|---|---|
| | Aroma C1 | Color C2 | Taste C3 | Texture C4 | Aftertaste C5 | Defect C6 | Overall Acceptance C7 |
| P1 | 0.328 | 0.351 | 0.317 | 0.434 | 0.332 | 0.341 | 0.308 |
| P2 | 0.398 | 0.377 | 0.346 | 0.415 | 0.361 | 0.362 | 0.388 |
| P3 | 0.429 | 0.427 | 0.455 | 0.394 | 0.397 | 0.356 | 0.455 |
| P4 | 0.422 | 0.466 | 0.499 | 0.391 | 0.471 | 0.481 | 0.453 |
| P5 | 0.365 | 0.345 | 0.363 | 0.374 | 0.378 | 0.404 | 0.396 |
| P6 | 0.330 | 0.339 | 0.317 | 0.321 | 0.363 | 0.352 | 0.317 |
| P7 | 0.359 | 0.316 | 0.302 | 0.298 | 0.324 | 0.328 | 0.293 |

**Table 6.** Attribute value optimization results

| Alternative | Criteria | | | | | | |
|---|---|---|---|---|---|---|---|
| | Aroma C1 | Color C2 | Taste C3 | Texture C4 | Aftertaste C5 | Defect C6 | Overall Acceptance C7 |
| P1 | 0.054 | 0.060 | 0.073 | 0.051 | 0.031 | 0.024 | 0.047 |
| P2 | 0.065 | 0.065 | 0.080 | 0.048 | 0.034 | 0.025 | 0.060 |
| P3 | 0.070 | 0.073 | 0.105 | 0.046 | 0.038 | 0.025 | 0.070 |
| P4 | 0.069 | 0.080 | 0.115 | 0.046 | 0.045 | 0.033 | 0.070 |
| P5 | 0.060 | 0.059 | 0.083 | 0.044 | 0.036 | 0.028 | 0.061 |
| P6 | 0.054 | 0.058 | 0.073 | 0.037 | 0.034 | 0.024 | 0.049 |
| P7 | 0.059 | 0.054 | 0.069 | 0.035 | 0.031 | 0.023 | 0.045 |

## 3.5 Multi-objective optimization value of commercial Pliek-U

After getting the value of the normalization result of the commercial Pliek-U decision matrix, the calculation of the MOORA multi-objective optimization value was carried out, namely by multiplying the criterion weight and the normalization value of the decision matrix ($Wj*Xij$) using Eq. (3). The results of the calculation of the multi-objective optimization value are revealed in Table 6.

The next was to determine the value of $Yi$, which was done by subtracting the maximum value and the minimum value. The maximum value was the value that had a benefit weight while the minimum value was a value that had a cost weight. After getting the commercial $Yi$ Pliek-U value, the next step was to determine the ranking of commercial Pliek-U products (Table 7).

**Table 7.** The results of the commercial $Yi$ Pliek-U value based on MOORA method

| Alternative | Maximum C1+C2+C3+C4+C5+C7 | Minimum C5+C6 | $Yi$ Max-Min |
|---|---|---|---|
| P1 | 0.316 | 0.024 | 0.293 |
| P2 | 0.352 | 0.025 | 0.327 |
| P3 | 0.402 | 0.025 | 0.377 |
| P4 | 0.424 | 0.033 | 0.390 |
| P5 | 0.343 | 0.028 | 0.315 |
| P6 | 0.306 | 0.024 | 0.282 |
| P7 | 0.293 | 0.023 | 0.270 |

## 3.6 The ranking value of commercial Pliek-U from the MOORA calculation result

After obtaining the value of the commercial Pliek-U, the ranking was carried out on the $Yi$ value which would later determine the ordered rank of commercial Pliek-U. The ordered rank of commercial Pliek-U is shown in Table 8.

**Table 8.** The ranking results of commercial Pliek-U MOORA method

| Alternative | $Yi$ Max-Min | Ranking |
|---|---|---|
| P1 | 0.293 | 5 |
| P2 | 0.327 | 3 |
| P3 | 0.377 | 2 |
| **P4** | **0.390** | **1** |
| P5 | 0.315 | 4 |
| P6 | 0.282 | 6 |
| P7 | 0.270 | 7 |

## 3.7 Product acceptance rate

Each panelist had a different acceptance level for each product alternative, mainly due to differences in the production system. Each commercial Pliek-U product used had its own characteristics affecting preference of the panelists. The Pliek-U product with the sample code P4 got the highest score with a value of 0.390 (rank 1). The aroma of sample P4 had the following characteristics: having a distinctive odor from Pliek-U, dark brown in color, having an acid taste favored by panelists, having a dry or not watery texture, no taste remains in the mouth, and no other taste which appeared when Pliek-U was eaten. Based on overall acceptance, this Pliek-U was highly preferred. The other commercial Pliek U

rankings were as follows: sample code P3 (rank 2) having a value of 0.377, P2 (rank 3) having a point of 0.327, P5 (rank 4) was being of 0.315, P1 (rank 5) with the value of 0.293, P6 (rank 6) having a value of 0.282, and P7 (rank 7) having a value of 0.270 (Table 8).

The application of MOORA method has been able to assess the acceptance of Pliek-U products properly and quickly [9, 29]. In principle, the method aims to determine the best alternative from the available ones [30]. The system in this method produces output in the form of ranking [31]. Therefore, the MOORA method contributes to building the best alternative from a number of available ones [9].

## 4. CONCLUSION

The panelists sensory analysis utilizing MOORA method revealed that alternative P4 was ranked 1, which was chosen as the best commercial Pliek-U. The characteristics are that it has a distinctive odor from Pliek-U, dark brown in color, having an acid taste favored by panelists, having a dry texture, no taste remains in the mouth, and no other taste which appeared when Pliek-U was eaten. Based on overall acceptance, Pliek-U is highly preferred because it has the highest sensory scores on all criteria attributes. Overall, the results of this study indicate that sensory assessment is very important to assess the attributes or quality of Pliek-U. Using the MOORA method in this study solved the problem of finding the best alternative for Pliek-U commercial.

This research is expected to provide information to producers and industry regarding the characteristics of the Pliek-U sensory profile based on consumer perceptions and can also be used to develop Pliek-U products according to consumers' ideal perceptions.

For the next research, a sensory assessment will be carried out using the MOORA method with a larger and more diverse number of panelists, as well as using statistical analysis to see the significant influence of sensory criteria.

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