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# Sensory Assessment of Gayo Arabica Coffee at Various Altitudes Using V60 Brewing

Rahmat Fadhil[1,2*], Sri Hartuti[1], Sri Maryuna[1], Basri A. Bakar[3]

[1] Department of Agricultural Engineering, Faculty of Agriculture, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia
[2] Aceh Cocoa and Coffee Research Institute, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia
[3] Food Crop Research Center, Agriculture and Food Research Organization, National Research and Innovation Agency, Jakarta 10340, Indonesia

Corresponding Author Email: rahmat.fadhil@usk.ac.id



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**ABSTRACT**

This study aimed to determine the sensory preferences of Gayo Arabica coffee products from various altitudes in Gayo Highland, Province of Aceh, Indonesia, using V60 brewing. The decision-making system regarding product acceptance preferences refers to sensory assessment by panelists using Fuzzy Simple Additive Weighting (FSAW) method. Compared to other decision-making models, the advantage of the FSAW method lies in its ability to carry out assessments more precisely because it is based on predetermined attribute values and preference weights. Apart from that, FSAW can also select the best alternative from some existing alternatives because of the ranking process after determining the weight value for each attribute. This study used Gayo Arabica coffee from 5 altitudes, namely <1,000 masl, 1,000-1,200 masl, 1,200-1,400 masl, 1,400-1,600 masl, and >1,600 masl. The sensory assessment criteria for Gayo Arabica coffee of various altitudes included aroma, flavor, aftertaste, acidity, body, sweetness, and balance. This research used nine identified panelists with criteria including being an arabica coffee connoisseur, knowing about Gayo Arabica coffee, being used to consuming manually brewed coffee, being able to provide a sensory assessment of coffee, and not having any illnesses such as coughs, flu, canker sores and stomach ulcers. The results showed that the flavor criterion was ranked first as a priority in the sensory assessment of Gayo Arabica coffee, with a value of 0.183. Furthermore, sequentially, the aroma criterion was ranked second (0.177), balance was ranked third (0.137), sweetness was ranked fourth (0.134), aftertaste was ranked fifth (0.131), body was ranked sixth (0.124), and acidity was in the seventh rank (0.113). Sensory assessment of Gayo Arabica coffee at various altitude using V60 brewing showed that altitude >1,600 masl with a value of 0.999 ranked 1$^{st}$, then altitude 1,200-1,400 with a value of 0.937 (ranked 2$^{nd}$), altitude 1,400-1,600 masl with a value of 0.892 (ranked 3$^{rd}$), an altitude of 1,000-1,200 meters above sea level with a value of 0.817 (ranked 4$^{th}$), and altitudes of <1,000 meters above sea level with a value of 0.800 (ranked 5$^{th}$). In this study, the Fuzzy Simple Additive Weighting (FSAW) method was employed as a decision-making system, facilitating the identification of the optimal planting altitude for Gayo Arabica coffee with V60 brewing, based on sensory evaluations. This approach significantly simplified the decision-making process.

## 1. INTRODUCTION

Coffee is an important crop in the plantation industry, and it guarantees the economic sustainability of farmers in tropical countries [1]. Several types of coffee cultivated in Indonesia are Robusta, Arabica, and Liberica coffee. Coffee, which is currently the prima donna of the world, is Arabica coffee. One of Indonesia's main Arabica coffee producers is Aceh Province, which is famous for Gayo Arabica coffee. Three districts in Aceh, which are the main centers for producing Arabica coffee, are Aceh Tengah, Gayo Lues, and Bener Meriah [2]. Arabica coffee (*Coffea arabica* L) is a type of coffee that is very popular with the public. It is usually consumed as a drink, namely by brewing coffee grounds using hot water. In general, there are various altitudes for planting Arabica coffee, and each altitude has a variety of tastes.

The altitude at which Arabica coffee is planted influences the physical quality and taste produced [3]. Arabica coffee grows well at altitudes above 1,000 meters above sea level. In addition, the physical quality of Arabica coffee beans farmers produce varies between altitudes. Some research has proven the effect of altitudes on the physical quality of Arabica coffee. In addition, several studies have also stated that the place of growth also affects the taste of Arabica coffee [4]. The production process also provides unique coffee sensations, such as roasting, steeping, and mixing with other beverages. Gayo Arabica coffee (Gayo Coffee) is quite well-known in Indonesia and the world because this type of coffee has a

distinctive taste and is one of the leading export commodities for the people of the Gayo highlands [5, 6]. According to Purba et al. [7], the growing environment influences the taste quality of coffee. Coffee grown at higher altitudes usually tastes better than coffee grown at lower altitudes.

One method of brewing coffee manually is the V60 brewing method, which has the principle of flowing hot water over coffee grounds on filter paper. Filter paper serves to prevent the coffee grounds from dissolving into the water. This coffee brewing principle is also known as pour-over V60. According to Syarifuddin and Yusriyani [8], pour-over V60 is a tool to brew coffee manually (manual brew) without using a machine. Brewing coffee with this method gives a stronger aroma and clean coffee results and accentuates certain characteristics. According to Lingle [9], in general, three processes occur during brewing: wetting, extraction, and hydrolysis. Wetting is the process by which the coffee grounds absorb water; extraction is the process of dissolving coffee grounds when exposed to water, which becomes coffee water; while hydrolysis is the term for a general chemical reaction that occurs when water reacts with other components aiming to change or break these components when extraction occurs. Therefore, particle size and brewing technique affect the resulting coffee flavor attributes [10].

Sensory assessment uses the five human senses: eyes, nose, mouth, hands, and ears. Through these five basic senses, panelists can assess the sensory attributes of a product, such as color, appearance, shape, taste, and texture [11]. Sensory assessment is mainly felt by aroma receptors in the nose and taste receptors in the mouth, for example, the tongue as a sense of taste [12]. The Gayo Arabica coffee sensory testing technique using a cup of coffee is often called the cupping test. According to the Specialty Coffee Association of America SCAA [13], sensory assessment of coffee usually uses some parameters, such as Aroma, Flavor, Aftertaste, Acidity, Body, Sweetness, Uniformity, Clean Cup, Balance, Defect and Overall [13]. These parameters, either in whole or in part, are then used to assess consumer preferences using a decision support system method. Therefore, the panelists can be considered as representatives of consumers, especially those who understand coffee, to give preference to the results of the cupping test.

The decision-making system is part of a computer-based information system used to support decision-making. One of the decision-making methods is the Fuzzy Simple Additive Weighting (FSAW) method. Fuzzy means having an uncertain value (Fuzzyness) between right and wrong [14]. The Simple Additive Weighting (SAW) method is a search method for weighted sums for each criterion, followed by a ranking process to determine the best alternative [15]. According to Sihotang [16], the difference between Fuzzy-SAW and SAW lies in the implementation of values in the comparison matrix, which is represented by three variables (a, b, c) called the Triangular Fuzzy Number (TFN). The FSAW method can carry out assessments more precisely because it is based on attribute values and preference weights that have been determined, and in this case, the sensory attributes that will be evaluated. Then, based on the sensory attributes, the best alternative is selected by ranking the weight values for each sensory attribute.

This study aimed to determine sensory preferences of Gayo Arabica coffee products from various altitudes in Gayo highland, Province of Aceh, Indonesia, using V60 brewing and a decision support system in the form of the Fuzzy Simple Additive Weighting (FSAW) method. The SAW method is often also known as the weighted sum method. Fuzzy SAW is one of the methods for solving Fuzzy Multi-Attribute Decision Making (Fuzzy MADM) problems. The basic concept of the SAW method is to find the weighted sum of the performance ratings for each alternative on all attributes [17].

## 2. METHOD

The Gayo Arabica coffee used in this study was sourced from Aromabica Gayo International Inc., with variations in altitudes divided into five categories, namely <1,000 masl, 1,000-1,200 masl, 1,200-1,400 masl, 1,400-1,600 masl and >1,600 masl. The coffee used was processed with full wash processing. The research stages were carried out: preparation of coffee bean samples, brewing coffee grounds using the V60 tool, sensory testing, and decision-making using the Fuzzy Simple Additive Weighting (FSAW) method.

### 2.1 Coffee bean sample preparation

Gayo Arabica coffee beans were medium roasted at 203°C for 8 minutes [18] and then allowed to stand for 24 hours. Furthermore, the roasted coffee beans were stored in a closed container before being ground. Grinding of coffee beans was conducted with a grinder with a scale of 8 for medium-course fineness (medium-coarse) (Figure 1).

**Figure 1.** Gayo Arabica coffee powder with medium-course grinding level

### 2.2 Brewing coffee grounds using V60 brewing

The way to use the V60 brewing machine (Figure 2) in this study was to prepare 16 grams of medium-course ground coffee powder and 250 mL of hot water at 90°C [19]. The filter was rinsed with hot water to prevent the smell of the filter and coffee grounds from being brewed, and then the used rinse water was discarded.

**Figure 2.** V60 coffee brewer

Next, the coffee grounds were put into the dripper; hot water was poured in a constant and slow circular motion. The first pouring was for blooming with a volume of 30 mL of water, which was then waited for 30 seconds; the second pouring was to gain acidity with a volume of 110 mL of water with a duration of 40 seconds; then the third pouring was to obtain the body with a volume of water as much as 110 mL of water and wait for 40 seconds until the coffee stopped dripping. Next, the brew was stirred and poured into a standard double espresso coffee cup (60 mL) to be assessed sensory by each panelist.

### 2.3 Sensory test by panelists

Panelists who participated in the sensory test were identified panelists [20], totaling nine people. The criteria were as follows:

a. Arabica coffee connoisseur.
b. Knowing about Gayo Arabica coffee.
c. Accustomed to consuming coffee with manual brewing.
d. Able to provide a sensory assessment of coffee.
e. Not currently in a state of illness, such as coughing, flu, canker sores, and ulcers, which could affect the sensory assessment process.

This study used seven assessment criteria, namely Aroma, Flavor, Aftertaste, Acidity, Body, Sweetness, and Balance. These criteria, also known as assessment attributes, are general criteria that make it easier for panelists to identify the sensors of each coffee brew produced. The weight of the importance of the criteria was assessed based on the knowledge of the panelists regarding the taste of coffee, with the aim of determining how important each criterion was in assessing the taste of coffee (Table 1).

The value of the weight of the importance of the criteria was carried out before the product sample was presented. The assessment of the weight of this criterion referred to the definition of each criterion and the knowledge of the panelists while being connoisseurs of Arabica coffee. The resulting importance level weight played an important role in the decision-making process using the Fuzzy Simple Additive Weighting (FSAW) method.

**Table 1.** Assessment of the importance of Gayo Arabica coffee flavor weight

| Attribute | Weight of Importance Level (100%) |
|---|---|
| Aroma | ... |
| Flavor | ... |
| Aftertaste | ... |
| Acidity | ... |
| Body | ... |
| Sweetness | ... |
| Balance | ... |
| **Total Weight** | **100%** |

In the next stage, the panelists assessed the acceptance of Gayo Arabica coffee brewed with V60 brewing from various altitudes based on the taste criteria in Table 1. The panelists were presented with five samples of Gayo Arabica coffee steeped from various altitudes, then the panelists identified the flavors of each sample with the same assessment criteria determined. The rating scale used refers to the level of product acceptance [21], as shown in Table 2.

**Table 2.** Product acceptance level

| Scale | Product Acceptance Rate |
|---|---|
| 1 | level 1 (lowest) |
| 2 | level 2 |
| 3 | level 3 |
| 4 | level 4 |
| 5 | level 5 (highest) |

### 2.4 Fuzzy Simple Additive Weighting (FSAW) method

The Fuzzy SAW method was chosen to determine the weight value of each criterion, then carry out a ranking process from a number of available alternatives to select the best alternative [22]. The decision-making steps using the Fuzzy Simple Additive Weighting method were as follows [16, 23]: Selecting the criteria used as a reference in decision-making, namely ($C_j$ = 1, 2...$m$) and determining the panelists ($fk$ = 1, 2..$n$) for decision making. The criteria used in this study included aroma, flavor, aftertaste, acidity, body, sweetness, and balance. The decision alternatives considered were the altitude of Gayo Arabica coffee growing, namely <1,000 masl, 1,000-1,200 masl, 1,200-1,400 masl, 1,400-1,600 masl, and >1,600 masl.

a. Giving weight to each criterion by the panelists ($fk$ = 1, 2... $n$).
b. Assigning a rating according to the level of assessment by the panelists for each alternative of Gayo Arabica coffee altitudes ($A_i$ = 1, 2, ... 5) from all sensory criteria.
c. Determining the Triangular Fuzzy Number (TFN) value (Table 3), which consisted of the lower (l), middle (m), and upper (u) limit values of each alternative on all criteria.
d. Calculating the average value of the fuzzy number ($A_{jk}$) and the defuzzification value (e) of each criterion for all alternatives.

$$A_{jk} = \frac{f_{j1}^{k} + f_{j2}^{k} + \cdots f_{jn}^{k}}{n} \quad (1)$$

where, $f_{jn}^{k}$ is the fuzzy number for each criterion in each alternative, and $n$ is the number of numbers in the Triangular Fuzzy Number (TFN).

**Table 3.** TFN membership rating scale and function

| Value | Level | TFN Element of Function |
|---|---|---|
| 1 | level 1 (lowest) | 1,1,2 |
| 2 | level 2 | 1,2,3 |
| 3 | level 3 | 2,3,4 |
| 4 | level 4 | 3,4,5 |
| 5 | level 5 (highest) | 4,5,5 |

The formula for calculating the defuzzification value:

$$e = \frac{(a + b + c)}{3} \quad (2)$$

where, $a$ denotes the smallest fuzzy number, $b$ denotes the middle fuzzy number, and $c$ denotes the largest (top) fuzzy number.

e. Determining the decision matrix for all criteria and alternatives from the defuzzification results.
f. Determining the normalized matrix for all criteria

and alternatives. Where $r_{ij}$ is the normalized performance rating of alternative $A_i$ on $C_j$ criteria; =1, 2...*m* with the formula below [15].

$$Rij = \begin{cases} \frac{X_{ij}}{max\ X_{ij}} & \text{If } j \text{ is the profit attribute } (benefit) \\ \frac{min\ X_{ij}}{X_{ij}} & \text{If } j \text{ is the cost attribute } (cost) \end{cases} \quad (3)$$

where, $X_{ij}$ shows the attribute value of each criterion, *max* $X_{ij}$ is the biggest value of each criterion, *min* $X_{ij}$ is the smallest value of each criterion, *benefit* shows the biggest value is the best, and *cost* shows the smallest value is the best.

g. The calculation or ranking process used the formula as below.

$$V_i = \sum_{j=1}^{n} W_{ij} r_{ij} \quad (4)$$

where, $V_i$ is the final value, $W_{ij}$ is the predetermined weight, and $R_{ij}$ is the normalized matrix.

A larger $V_i$ value indicates that alternative $V_i$ is preferred. The overall research stages can be observed in Figure 3.

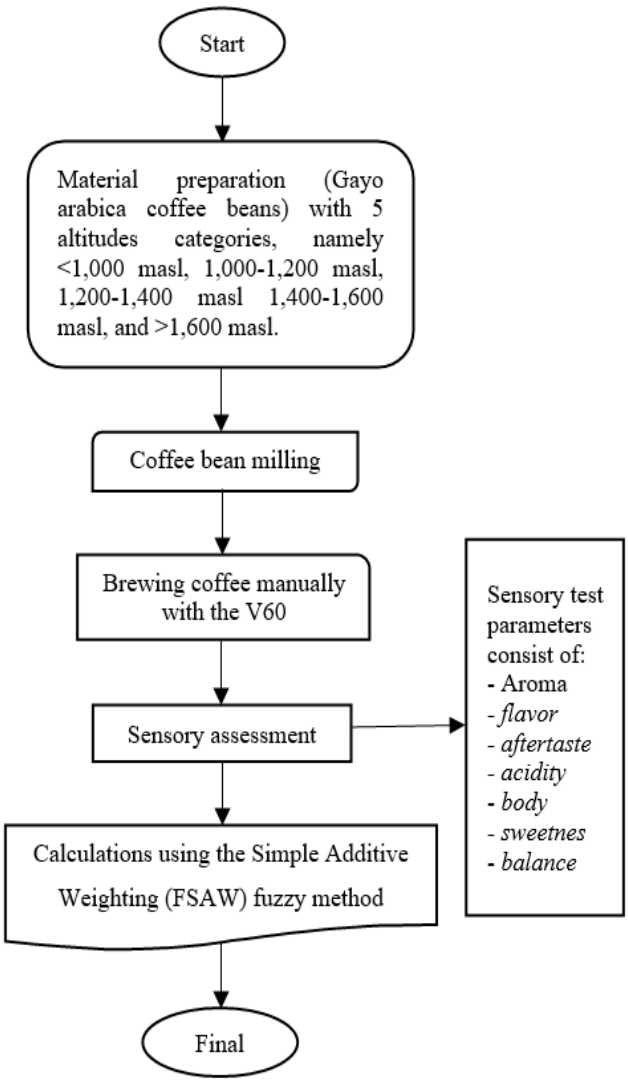


**Figure 3.** Research flow chart

## 3. RESULT AND DISCUSSION

### 3.1 Criteria weight

The weight of importance on each criterion based on the panelist's assessment revealed the following values: Flavor (0.183), Aroma (0.177), Balance (0.137), Sweetness (0.134), Aftertaste (0.131), Body (0.124), and Acidity (0.113) (Table 4).

**Table 4.** The weight value of each criterion

| Criteria | Weight | Description | Level |
|---|---|---|---|
| Flavor | 0.183 | Benefit | 1 |
| Aroma | 0.177 | Benefit | 2 |
| Balance | 0.137 | Benefit | 3 |
| Sweetness | 0.134 | Benefit | 4 |
| Aftertaste | 0.131 | Benefit | 5 |
| Body | 0.124 | Benefit | 6 |
| Acidity | 0.113 | Benefit | 7 |

Based on the results of the panelist's assessment, the flavor criterion received the highest score (0.183) compared to the other criteria. According to Ranitaswari et al. [24], the flavor of a product is a very important criterion because flavor describes the quality of the product. The results of Fadhil and Nurba's research [25] stated that flavor is the most important criterion in the sensory assessment of Gayo Arabica coffee compared to other criteria. According to Agustina et al. [26], flavor is one of the important criteria that can influence consumers' final decision in accepting or rejecting a product. The criterion with the second largest weight was aroma, with a value of 0.177. According to Fibrianto and Ramanda [27], aroma can affect consumer perceptions. Perception is a psychological factor that can influence an individual in giving an assessment [28].

Furthermore, the balance criterion was ranked third with a value of 0.137. Balance means that all aspects of flavor, aftertaste, acidity and body are balanced. This also means that if one aspect is less or more than the sample being tested, the resulting balance value will decrease. In other words, balance means that one flavor is not dominant [25]. Sweetness criterion gained the fourth rank with a value of 0.134. Sweetness is the level of sweetness or slightly sweet taste. The panelists preferred this criterion based on their level of preference for the resulting Gayo Arabica coffee taste. According to Dairobbi et al. [29], the sweetness criterion is one of the most important criteria in the sensory assessment of Gayo Arabica coffee taste, especially the sweet taste, which gives a distinct sensation of the natural taste produced.

The aftertaste criterion got the fifth rank with a value of 0.131. Aftertaste means the taste left in the mouth from the back of the palate after the coffee is swallowed. According to Musika [30], the lingering taste is caused by the coffee's overall characteristics, which stop at the senses of taste, such as flavor, acidity and body. The body criterion was ranked sixth, with a value of 0.124. Body means the texture of coffee that can be felt by the senses, whether heavy/thick or light liquid in the mouth, especially that which is felt between the tongue and the roof of the mouth. The acidity criterion was ranked seventh with a value of 0.113. Acidity is the character of acidity that appears closer to the taste that has been tasted, a perception of sour taste appears, especially in sour fruit such as oranges, tamarind, and other acidic properties [25].

After the panelists determined the weight of the criteria, they conducted a sensory assessment of each alternative altitude of Gayo Arabica coffee planting based on all aroma, flavor, aftertaste, acidity, body, sweetness, and balance criteria. Furthermore, the results of the sensory assessment by all panelists were converted into a Triangular Fuzzy Number (TFN) value, consisting of lower, middle and upper limit values, which then mean the lower limit value for all alternatives for each criterion as well as the middle and upper values are calculated using Eq. (1). The average results of the Triangular Fuzzy Number (TFN) values will be defuzzification by adding up the lower, middle and average upper limit values, then dividing by three to get the defuzzification value of all alternatives for each criterion [16] using the Eq. (2), as shown in Table 5.

### 3.2 Decision matrix

The results of the sensory assessment by identified panelists who had been defuzzification were then tabulated in the decision matrix of each alternative on all criteria (Table 6). Data from the final calculation of the defuzzification lower (L), middle (M), and upper (U) fuzzy values were then tabulated in the form of a decision matrix of all alternatives for each criterion. Next, the highest maximum value of each criterion was selected, namely the value of the greatest benefit that showed the best value [31]. Next, a normalized matrix was formed from all alternatives on each criterion.

**Table 5.** The average value of the Triangular Fuzzy Number (TFN) and the results of the defuzzification of all alternatives for each criterion

| Criteria | Average Value of Triangular Fuzzy Number (TFN) | | | | Defuzzification |
|---|---|---|---|---|---|
| | Alternative | Lower | Middle | Upper | |
| Aroma | <1,000 | 3 | 4 | 5 | **4** |
| | 1,000-1,200 | 2 | 3 | 4 | **3** |
| | 1,200-1,400 | 3 | 4 | 5 | **4** |
| | 1,400-1,600 | 2 | 3 | 4 | **3** |
| | > 1,600 | 3 | 4 | 5 | **4** |
| Flavor | <1,000 | 1 | 2 | 3 | **2** |
| | 1,000-1,200 | 2 | 3 | 4 | **3** |
| | 1,200-1,400 | 2 | 3 | 4 | **3** |
| | 1,400-1,600 | 2 | 3 | 4 | **3** |
| | >1,600 | 2 | 3 | 4 | **3** |
| Aftertaste | <1,000 | 2 | 3 | 4 | **3** |
| | 1,000-1,200 | 2 | 3 | 4 | **3** |
| | 1,200-1,400 | 2 | 3 | 4 | **3** |
| | 1,400-1,600 | 2 | 3 | 4 | **3** |
| | >1,600 | 2 | 3 | 4 | **3** |
| Acidity | <1,000 | 2 | 3 | 4 | **3** |
| | 1,000-1,200 | 2 | 3 | 4 | **3** |
| | 1,200-1,400 | 2 | 3 | 4 | **3** |
| | 1,400-1,600 | 2 | 3 | 4 | **3** |
| | >1,600 | 3 | 4 | 5 | **4** |
| Body | <1,000 | 2 | 3 | 4 | **3** |
| | 1,000-1,200 | 2 | 3 | 4 | **3** |
| | 1,200-1,400 | 3 | 4 | 5 | **4** |
| | 1,400-1,600 | 3 | 4 | 5 | **4** |
| | >1,600 | 3 | 4 | 5 | **4** |
| Sweetness | <1,000 | 1 | 2 | 3 | **2** |
| | 1,000-1,200 | 1 | 2 | 3 | **2** |
| | 1,200-1,400 | 2 | 3 | 4 | **3** |
| | 1,400-1,600 | 2 | 3 | 4 | **3** |
| | >1,600 | 2 | 3 | 4 | **3** |
| Balance | <1,000 | 2 | 3 | 4 | **3** |
| | 1,000-1,200 | 2 | 3 | 4 | **3** |
| | 1,200-1,400 | 2 | 3 | 4 | **3** |
| | 1,400-1,600 | 2 | 3 | 4 | **3** |
| | >1,600 | 3 | 4 | 5 | **4** |

**Table 6.** Decision matrix value of all alternatives on each criterion

| Alternative | Gayo Arabica Coffee Sensory Criteria | | | | | | |
|---|---|---|---|---|---|---|---|
| | Aroma | Flavor | Aftertaste | Acidity | Body | Sweetness | Balance |
| <1,000 | 4 | 2 | 3 | 3 | 3 | 2 | 3 |
| 1,000-1,200 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| 1,200-1,400 | 4 | 3 | 3 | 3 | 4 | 3 | 3 |
| 1,400-1,600 | 3 | 3 | 3 | 3 | 4 | 3 | 3 |
| >1,600 | 4 | 3 | 3 | 4 | 4 | 3 | 4 |
| **Max** | **4** | **3** | **3** | **4** | **4** | **3** | **4** |

**Table 7.** Normalized matrix values of all alternatives on each criterion

| Alternative | Criteria | | | | | | |
|---|---|---|---|---|---|---|---|
| | Aroma | Flavor | Aftertaste | Acidity | Body | Sweetness | Balance |
| <1,000 | 1 | 0.67 | 1 | 0.75 | 0.75 | 0.67 | 0.75 |
| 1,000-1,200 | 0.75 | 1 | 1 | 0.75 | 0.75 | 0.67 | 0.75 |
| 1,200-1,400 | 1 | 1 | 1 | 0.75 | 1 | 1 | 0.75 |
| 1,400-1,600 | 0.75 | 1 | 1 | 0.75 | 1 | 1 | 0.75 |
| >1,600 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**Table 8.** Ranking of Gayo Arabica coffee alternatives at various altitudes

| Alternative | C1 | C2 | C3 | C4 | C5 | C6 | C7 | Vi | Ranking |
|---|---|---|---|---|---|---|---|---|---|
| <1,000 | 0.177 | 0.122 | 0.131 | 0.085 | 0.093 | 0.089 | 0.103 | **0.800** | **5** |
| 1,000-1,200 | 0.133 | 0.183 | 0.131 | 0.085 | 0.093 | 0.089 | 0.103 | **0.817** | **4** |
| 1,200-1,400 | 0.177 | 0.183 | 0.131 | 0.085 | 0.124 | 0.134 | 0.103 | **0.937** | **2** |
| 1,400-1,600 | 0.133 | 0.183 | 0.131 | 0.085 | 0.124 | 0.089 | 0.103 | **0.892** | **3** |
| >1,600 | 0.177 | 0.183 | 0.131 | 0.113 | 0.124 | 0.134 | 0.137 | **0.999** | **1** |

Notes: C1 = aroma, C2 = flavor, C3 = aftertaste, C4 = acidity, C5 = body, C6 = sweetness, C7 = balance.

### 3.3 Normalization matrix

The result of calculating the normalized matrix value was the value of the calculation of all alternatives for each Gayo Arabica coffee criterion in the decision matrix value above in Table 6, which was then divided by the maximum value in order to get the normalized matrix value using Eq. (3) (Table 7).

### 3.4 Determining ranking

The results of the normalized matrix values in Table 6 multiplied by the respective criterion weight values in Table 4 were used to determine the ranking (using Eq. (4)). The calculation results can be seen in Table 8.

Sensory assessment of Gayo Arabica coffee at various heights using the Fuzzy-Simple Additive Weighting (SAW) method resulted in a ranking based on 5 coffee altitudes. The first rank with the highest value was achieved by Gayo Arabica coffee at an altitude of > 1,600 masl, with a value of 0.999. The second rank was obtained by Gayo Arabica coffee with an altitude of 1,200-1,400 meters above sea level, with a value of 0.937. The third rank was occupied by Gayo Arabica coffee with an altitude of 1,400-1,600 meters above sea level, with a value of 0.892. The fourth rank was Gayo Arabica coffee with an altitude of 1,000-1,200 masl, with a value of 0.817, while the fifth rank was achieved by Gayo Arabica coffee with a height of <1,000 masl with a value of 0.800. According to Qadry et al. [3], for Arabica coffee plants, the higher the coffee plant land above sea level, the smaller the value of defects in the coffee beans. Vice versa, coffee plants grown at low altitudes have a high defect value of the coffee beans, so the coffee beans are of low quality.

Altitude >1,600 meters above sea level got the first place because it had a high level of preference for each criterion of aroma, flavor, aftertaste, acidity, body, sweetness, and balance compared to other altitudes. According to Purba et al. [7], this occurs because the quality of coffee flavor is affected by the growing environment. Coffee grown on high land will have higher quality. According to Dessalegn et al. [32], arabica coffee grown at higher altitudes will have a higher chlorogenic acid content. This compound acts as an antioxidant and has been described as an important component for disease resistance in coffee beans.

An altitude of 1,200-1,400 masl obtained the second rank, while an altitude of 1,400-1,600 masl got a rank of 3. At an altitude of 1,200-1,400 masl, the aroma criteria value was high, namely 0.177, while at an altitude of 1,400-1,600 masl, the aroma criterion value was lower, namely 0.133. This happened because, at an altitude of 1,200-1,400 meters above sea level, the aroma criterion was preferred with a preference level of 4 on the average value of the sensory assessment of the decision matrix. While an altitude of 1,400-1,600 meters above sea level obtained a preference level of 3 in the aroma criterion caused by several factors, such as brewing equipment, level of coffee bean grinding and coffee bean processing, as in the results of research by Heppi et al. [33] which showed that Gayo Arabica coffee at an altitude of 1,200-1,400 is preferred in the preference for receiving products using espresso machine brewers with wet or semi-wet processing, with a fine level of fineness in the coffee powder used.

Altitude 1,000-1,200 masl gained fourth place because, at that altitude, coffee had a flavor value of a preference level of 3, with a low aroma value of a preference level of 3. Altitude <1,000 masl achieved the fifth rank because of low flavor value with a preference level of 2 and high aroma value with a preference level of 4. However, the maximum value of the flavor criterion in the low decision matrix was 3, while the maximum value in the aroma criterion was 4. According to Worku et al. [34], this is due to the fact that the content of chemical compounds from coffee in higher areas is more complex than coffee grown in lower areas.

## 4. CONCLUSION

The sensory test results of Gayo Arabica coffee at various altitudes by identified panelists using the Fuzzy-Simple Additive Weighting (SAW) method showed that the flavor criterion was ranked first with a value of 0.183, which was the highest priority for Gayo Arabica coffee flavor. Aroma was ranked second (0.177), balance was ranked third (0.137), sweetness was ranked fourth (0.134), aftertaste was ranked fifth (0.131), body was ranked sixth (0.124), and acidity was ranked seventh (0.113). Determining the assessment scale and membership function in the Triangular Fuzzy Number, as well as the results of the average value of the fuzzy number and defuzzification value, thus producing a decision matrix for different levels of product acceptance at each altitude of Gayo Arabica coffee.

Sequentially, altitude >1,600 masl with a value of 0.999 (rank 1), altitude 1,200-1,400 with a value of 0.937 (rank 2), altitude 1,400-1,600 masl with a value of 0.892 (rank 3), altitude 1,000-1,200 masl with a value of 0.817 (rank 4), and altitude <1,000 masl with a value of 0.800 (rank 5). The implications of these findings confirm that Gayo Arabica coffee grown at an altitude of 1200 masl to above 1600 masl is the preference for receiving the best product with V60 brewing. This finding also serves as strategic information for recommending coffee beans produced at this altitude to producers and customers who want to get Gayo Arabica coffee with the best sensory quality. The use of the Fuzzy Simple Additive Weighting (FSAW) method as the decision-making system used in this study was able to provide a solution in determining the best alternative for each altitude of Gayo Arabica coffee planting with V60 brewing, so this made it easier to choose several available alternatives.

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