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SENSORY EVALUATION OF GAYO PEABERRY ARABICA COFFEE BY USING THE AHP METHOD

R. Fadhil, S. Safrizal, R. Khathir, P. Navisah

As other peaberrys, Gayo peaberry arabica coffee is very attractive because it has single larger and rounder seed. It is believed that the peaberry has superior flavor profile such as more fragrant aroma, stronger flavor, and denser than other arabica coffees. The purpose of this study was to evaluate the Gayo peaberry arabica coffee by using the analytical hierarchy process (AHP) method. Three varieties of Gayo peaberry arabica coffee were investigated i.e., Tim-tim, Bor-bor, and P88, while the processing method used were semi-wash and fully-wash methods. The sensory parameters observed included fragrance, flavor, acidity, body, and sweetness. The results showed that flavor (0.338) was the most important criterion than other taste criteria (fragrance 0.241; sweetness 0.196; acidity 0.115; and body 0.111). The variety that had the highest product acceptance rate was the Tim-tim variety processed by a full-wash method with a value of 0.203. The overall result of data analysis was acceptable because it had a consistency ratio below 0.1 (10%).

Keywords: *analytical hierarchy process; sensory evaluation; Gayo peaberry arabica; monocot; coffee varieties*

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Introduction

Gayo arabica coffee from Aceh is one of the most well-known coffee varieties from Indonesia. Gayo coffee is a type of arabica coffee that grows in the

Gayo highlands, covering the districts of Aceh Tengah, Bener Meriah and Gayo Lues [1]. Arabica coffee has high flavor quality and lowers caffeine content than robusta coffee, so the price of arabica coffee is also higher [2]. The three coffee-producing districts have suitable lands for growing coffee because it is located at altitude of more than 1,000 to 1,700 MASL (meters above sea level). Coffee plants in this area have been developed since 1908 and now have been planted in 97,796 ha of coffee plantation area [3].

One type of Gayo arabica coffee bean is monocot (one seed); it is also called the Gayo peaberry arabica coffee. Gayo peaberry arabica coffee is a unique type of coffee because it is different from other coffees with two seeds (dicot). This type of Gayo peaberry arabica coffee is very rare, and it is estimated that the production amount is only about 5-10% of the total coffee beans harvested [4]. Even though it looks irregular, Gayo peaberry arabica coffee has a more fragrant aroma, has a stronger flavor and is denser than other arabica coffees [5]. Due to its limited production and unique flavor, the price of Gayo peaberry arabica coffee is considerably high, up to IDR 300,000 per kilogram at farmer's price [6].

Gayo peaberry arabica coffee does not come from certain varieties or species; all types of coffee can be peaberry (monocot) coffee. Gayo peaberry arabica coffee, which comes from the arabica coffee type, has a very good taste, proven by a sensory evaluation. Sensory evaluation is an assessment carried out by using the human senses, namely eyes, nose, and hands. Sensory evaluation requires a product appraisal team of panelists. The assessment criteria by the panelists also depend heavily on the method used in a study [7; 8]. In this study, the authors used the Analytical Hierarchy Process (AHP) method to conduct a sensory evaluation of Gayo peaberry arabica coffee.

AHP is a general theory of measurement used to determine the ratio scale, either from discrete or continuous pairwise comparisons. AHP describes a problem of several complex criteria into a hierarchy, in which the problem can be broken down into groups so that the problem can be analyzed more structurally and systematically. This study aimed to conduct a sensory evaluation of some varieties and processing methods of Gayo peaberry arabica coffee by using the AHP approach. It is expected to determine the Gayo peaberry arabica coffee variety and processing method with the highest product acceptance. There are three types of varieties to be tested, including the varieties Tim-tim (1000-1400 MASL), Bor-bor (>1400 MASL) and P88 (<1400 MASL), which are processed using the semi-wash and full-wash methods, respectively. The results of this coffee sensory evaluation are expected to determine the type of Gayo peaberry arabica coffee variety with the highest alternative level of product acceptance based on the processing method (semi-wash/full wash).

Material and Methods

This research was conducted at the Post-Harvest Engineering Laboratory, Department of Agricultural Engineering, Faculty of Agriculture, Universitas Syiah Kuala, Banda Aceh, Indonesia. The data were collected from sensory evaluations by panelists following the Analytical Hierarchy Process (AHP) method, where decision making is done by identifying the structure of the problem which is then assessed to choose an alternative from a number of options available in problem-solving. AHP is used to make considerations in choosing the most preferred or preferred alternative [9;10]. To apply the AHP method in this study, a hierarchical model was compiled, which consists of 3 levels, namely goal, criteria and alternative solutions. The goal level was for the sensory evaluation of the Gayo peaberry arabica coffee, while the criteria level includes fragrance, flavor, acidity, body and sweetness. The alternative solutions level were the six treatments i.e., fully-washed Tim-tim, semi-washed Tim-tim, fully-washed Bor-bor, semi-washed Bor-bor, fully-washed P88, and semi-washed P88. There are several predetermined components in this study, as listed in Table 1.

Table 1.

Research components

No.	Component	Criteria
1.	Coffee	The coffee used in this study was Gayo peaberry arabica coffee of Tim-tim, Bor-bor and P88 varieties. Coffee was processed in 2 methods, fully-washed and semi-washed, then roasted at medium level.
2.	Tool	The grinder machine used was the Krups GVX231, and the coffee brewing machine was Delonghi EC0311.
3.	Panelist	1. Coffee expert 2. Knowing Gayo arabica coffee 3. In good health (no flu, mouth sores, coughs and other diseases) which can affect the sensory test assessment
4.	Rating system	The assessment was carried out by using a pairwise comparison test as listed in Table 2

In this study, the Gayo peaberry arabica coffee beans were processed directly by the Gayo farmers in Aceh Tengah district. The processing of coffee was carried out under 2 methods i.e., fully-washed and semi-washed, which consist of picking coffee beans, sorting fruit, peeling fruit skins, fermentation, drying, peeling the husks, sorting dry beans, and storage. The difference between the two methods is that the washing process of the fully-washed method was carried out after fermentation, while in the semi-washed method, the washing step did not include [11].

Table 2.

Pairwise comparison rating scale

Intensity of Importance	Description
1	Both criteria are very important
3	One criterion is less important than the others
5	One criterion is more important than the others
7	One criterion is clearly more important than the others
9	One criterion is absolutely more important than the others
2, 4, 6, 8	Adjacent consideration values

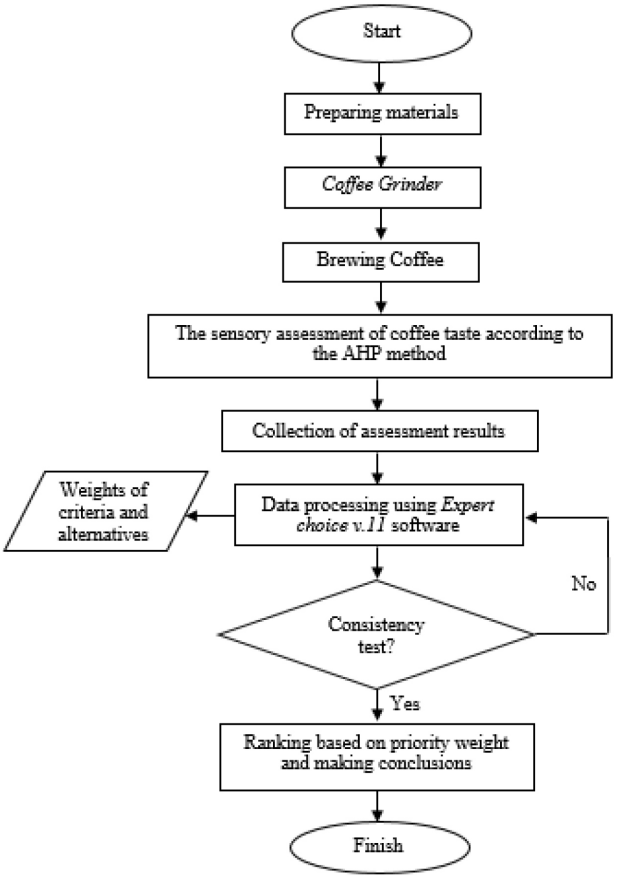

Fig. 1. Research flowchart

This washing after fermentation results in higher acidity. Coffee beans were then subjected to a medium-level of roasting process to produce a darker color, a balanced aroma, and varied flavor. The dry powder and brewed coffee had been prepared by using grinder and brewer machine, respectively. The panelists consist of 10 people (7 men and 3 women) who will judge based on coffee acceptance preferences through a questionnaire that has been prepared using a pairwise comparison rating scale (Table 2).

The assessment process was carried out separately, and there was no communication among the panelists. To achieve the study's objectives, the authors used quantitative data analysis. According to the AHP method, the calculation was carried out with the support of the expert choice version 11 application [12]. The research flow chart is presented in Fig. 1.

Research Results and Discussion

Coffee Taste criteria Selection

The selection of coffee taste criteria was based on the assessment of panelists who were considered to be able to make decisions and provide information about general criteria that are very important in coffee sensory evaluations. Five criteria for coffee taste i.e., fragrance, flavor, acidity, body, and sweetness, were used because they are considered to be very influential in creating the taste of the coffee. The results of the criteria assessment that the panelists had given were then analyzed by calculating the pairwise comparison matrix according to the Analytical Hierarchy Process (AHP) method, which represents the relative importance of one alternative to another.

Results showed that the highest criteria of Gayo peaberry coffee was the flavor with a weight of 0.338. It was followed by the criteria for fragrance 0.241, sweetness 0.196, acidity 0.115, and body 0.111 (Fig. 2). The inconsistency value was about 0.00799 or ≤ 0.1. Therefore, the data was consistent and can be accepted to determine the sensory characteristics of Gayo peaberry arabica coffee. Ranking of coffee criteria was carried out to facilitate overall alternative decision making. Najla [13] also said that the ranking function to determine the intensity that can be assigned to alternatives under the criteria would make it easier to rank alternatives.

The flavor of the coffee was influenced by the processing method, the roasting step, and the brewing method. Hidayatullah [14] stated that coffee beans will undergo a chemical change during the processing that produces a delicious flavor element after. The flavor would be felt by the tongue and the steam aroma would be indicated by the nose when the panelists sip the

coffee. As flavor received top priority in selecting coffee criteria, the flavor criterion was a very dominant consideration variable in determining the good and desirable taste of Gayo peaberry arabica coffee. Hayati et al. [15] also argued that flavor is an important attribute that affects a person's acceptance of a drink; therefore, it will also affect the high acceptance of coffee [16]. Clark [17] also stated that flavor is the most difficult component to assess because of the combination of aroma and taste in the mouth so that the flavor component plays an important role in the acceptance score of the food or drink being tested, so it is not a coincidence that the panelists gave weight to the importance of flavor.

However, the fragrance is considered as the second priority after flavor. The fragrance is the aroma of coffee after being ground and then brewed for consumption [18]. The coffee fragrance appears due to the presence of volatile compounds possessed by coffee so that it is captured by the human sense of smell [19]. According to Purwanto [20], the characteristic of the coffee fragrance can reflect the taste of the coffee. The aroma quality produced by coffee will differ depending on the coffee-producing region. Sulistyowati [21] had confirmed that the aroma of Gayo peaberry arabica coffee grown in the Gayo highlands has good quality.

The third priority is sweetness. It is a perception that emerges as a reaction to carbohydrate content [22]. Carbohydrates that break down into glucose will affect sweetness; the higher the glucose content, the sweeter the coffee taste [23]. Panelists also argued that coffee served hot can give a sweeter taste than that of served cold. Oktadina et al. [24] had demonstrated that the Brix degree of Gayo arabica coffee is higher and the coffee tastes sweeter. According to Dairobbi et al. [25], the sweetness criterion is one of the most important criteria in sensory assessment because sweetness has its own sensation with the resulting natural taste.

Furthermore, the acidity and the body criteria were accepted as last alternative at weight of 0.115 and 0.111, respectively. This finding was supported by Cheng et al. [26]. The acidity can be affected by the maturity of the coffee beans and the processing process, especially the fermentation process. As the weight of acidity and body are very low, it represented that the Gayo peaberry arabica evaluated was not dominant factor to taste of this coffee. Anggara et al. [27] reported that the high level of acidity made the coffee taste unpleasant, while Panggabean [28] had also revealed that the thicker the coffee, the more panelists would like the coffee because it has a stronger taste.

Selection of best coffee varieties and processing

Different varieties and coffee processing methods will produce different tastes so that the weight of the panelists' assessment would also be different for each variety and processing method assessed [29]. Coffee varieties were tested based on taste, which is the standard for arabica coffee assessment following the assessment of coffee taste criteria, namely fragrance, flavor, acidity, body, and sweetness, in line with the research by Yusianto et al. [30] and Bekele et al. [31].

After selecting the best criteria of sensory evaluation, the next investigation was done to select the best coffee varieties and processing methods. Based on the alternative weights at level 3 hierarchical structure (Fig. 3), it can be concluded that the variety and processing method had influenced the taste of Gayo peaberry arabica coffee. This finding is in line with Supriadi et al. [32] and Joet et al. [33].

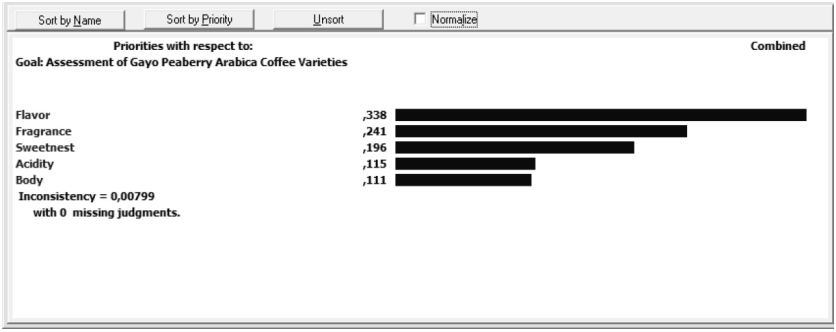

Fig. 2. Selection of taste criteria for Gayo peaberry arabica coffee

Results showed that the Tim-tim variety with fully-washed processing received the highest priority (0.203) compared to other treatments with a consistency ratio of 0.01. According to Tari et al. [34] the taste of Tim-tim Gayo peaberry arabica coffee processed using the fully-washed method has a unique taste. Tim-tim variety provides higher flavor and strong fragrance. Wahyuni [35] had mentioned that the Tim-tim variety processed by the fully-washed method had a strong enzymatic aroma and flavor. Supporting this finding, Ferreira et al. [36] stated that processing coffee with the fully-washed method is better than processing with the semi-washed because the mucus washed on the beans after the fermentation process can improve the body, taste, and aroma. The aroma is improved by forming flavor precursors [37].

The second priority level alternative was the semi-washed Bor-bor variety at weight of 0.177. The Bor-bor variety is a variety that resulted from the arti-

ficial selection of the Lini S and Catimor populations which are often referred to as the Gayo 2 variety. In general, the taste of the Bor-bor variety has high acidity, a thick body, and thick sweetness [38]. The panelists described that the fragrance and flavor of this combination were very balanced.

The other interesting findings from this research is that Tim-Tim variety is better to process through fully-washed method, but Bor-bor and P88 varieties are better to process by using semi-washed method. The Tim-Tim variety is more desirable when processed using the fully-washed method because the resulting flavor is more complex and delicious. However, the Bor-bor variety and P88 variety have low acidity level. Of course, the product acceptance of Bor-bor variety and P88 variety looks very different from Tim-tim variety, for which fully-washed processing is preferred, where Bor-bor variety and P88 variety are preferably processed semi-washed.

Lastly these results were a recommendation that certain processing methods and varieties give different taste sensations, so to determine a coffee product that has the highest acceptance rate can be conducted through a more intensive study of the coffee, especially regarding the varieties and processing methods used.

Applying the AHP method in multi-criteria decision-making is very easy to use and understand because it handles several criteria with certain permitted consistency values [39]. This method considers human judgments, experiences, perceptions and feelings in the decision-making process [13]. The perceptions included here are the panelists' perceptions who understand the problems to be resolved [40]. To determine the level of data consistency obtained, the AHP method calculation is also equipped with a Consistency Index calculation [41] Alternative priorities are consistent if it has a consistency value of ≤ 0.1; the alternative strategy is acceptable [42].

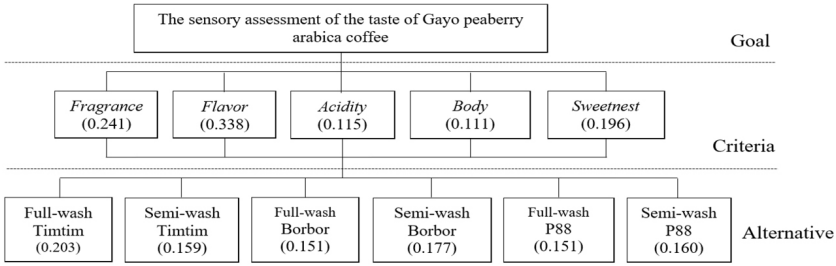

Fig. 3. Hierarchy structure of sensory assessment of the taste of Gayo peaberry arabica coffee

Conclusion

The study concluded that the most important criteria to determine the priority of Gayo peaberry arabica coffee taste to be accepted by panelists is the flavor criterion (0.338), followed by other criteria i.e., fragrance (0.241), sweetness (0.196), acidity (0.115), and body (0.111). The overall consistency weight of all level was less than 10%. Among the Gayo peaberry arabica coffee products, Tim-tim variety is better to be processed through the fully-washed method. In contrast, Bor-bor and P88 varieties are better to process under semi-washed method. The best combination according to AHP analysis was the Gayo peaberry coffee of Tim-Tim variety processed by fully-washed method.

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