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Assessment of Robusta Coffee Quality Using Parameters of Specialty Coffee Association by Analytical Hierarchy Process (AHP) Method

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ABSTRACT

Understanding differences of the interests and tastes of each consumer are the basis for developing Robusta coffee in Aceh. This study aims to obtain consumer preferences on Robusta coffee in term of quality parameters of the Specialty Coffee Association (SCA). Robusta coffee samples were obtained from three places, namely Tangse, Lamno and Bener Meriah. Post-harvest handling of coffee beans included dry and wet processes. Preparation of test samples was carried out by following the SCA protocol, coffee testing was carried out by 3 professional panelists (Q-Grader). Consumer preferences was analyzed using the analytic hierarchical process (AHP) method. The results of the study indicated that the taste of Robusta coffee with a weight value 0.36 is preferred over other parameters. Based on the taste test on respondents, the best coffee based on ranking using the AHP method is Lamno coffee with wet processing which has a preference level of 0.0429. The results is in accordance with the cupping test assessment and the taste assessment which lies in the assessment of the best coffee, namely Lamno coffee with wet processing achieving a total cupping score of 75.25. Using the Analytical Heirarchy Process (AHP) method Lamno Robusta coffee with wet processing is the best based on the quality parameters from the SCA.

1. INTRODUCTION

Indonesian is known as one of the largest coffee (*Coffea* sp.) producers in the world and ranks fourth after Brazil, Vietnam, and Colombia. According to the International Coffee Organization in 2016, Indonesian coffee production reached 358.620 ton. The coffee plant itself has been cultivated since the 15th century, and so far coffee has become one of the most consumed beverages and is even considered a modern lifestyle (Putri *et al*., 2017) and (Sabarni & Nurhayati, 2019). Robusta coffee (*Coffea canephora* L.) is known to have a higher and more caffeine content than Arabica coffee. Coffee beans naturally contain different types of compounds including caffeine, chlorogenic acid, carbohydrates, fats, amino acids, volatile compounds and minerals. Robusta coffee contains more caffeine than arabica coffee, so the stimulatory effect of Robusta coffee will be more than arabica coffee Robusta coffee has a characteristic that it can be grown in the lowlands, but the best place to plant this plant is 400-800 meters above sea level. Robusta coffee species grow in areas less than 1000 meters above sea level (Frega *et al*., 2015). The optimal temperature for growing Robusta coffee starts from 24-30°C with rainfall of 2000-3000 mm per year (Erdiansyah & Yusianto, 2012).

Coffee taste is a combination of flavor and aroma. All factors that affect the taste of coffee are influenced by the content of volatile compounds released by coffee when brewed (Asiah *et al*., 2017). According to the statement (Asiah *et al*., 2017), using the chloroform isolation procedure, quantitatively calculated the main methylxanthine (caffeine) in Arabica and Robusta Green Coffee samples. Detecting that the Robusta green coffee sample had a greater caffeine concentration (182 milligrams/ 100 grams of coffee) than Arabica green coffee (154 milligrams/ 100 grams of coffee).

Postharvest process for Robusta coffee is typically classified in three methods, namely semi-wet (semi-wet), wet (full wash), and dry (dry) (Nadya *et al*., 2024). Because dry method processing may be done with basic equipment, small farmers typically undertake it. Because the equipment is basic and feasible in a rural household, this processing method is straightforward to use. Harvesting, sorting fruit, drying, peeling, sorting dry beans, packaging, and storing coffee beans are the steps involved in the dry method of coffee processing (Mayrowani, 2013 & Caracostea *et al*., 2021). Origin of green bean is also influenced test of coffee (Ramanda *et al*., 2024).

Sage mentioned that all these factors affect the flavor of coffee, namely coffee quality, reaction order, agitation or turbulence, brewing technique, temperature, fineness of coffee grounds, time, and water (Sage, 2015). Sensory assessment is a method carried out by humans using the five human senses, namely the eyes, nose, mouth, hands and ears. Through these five basic senses, we can assess the sensory attributes of a product such as color, appearance, shape, taste, and texture and has been widely studied (Bach *et al*., 2012). Sensory testing is conducted to identify sensory differences between each sample, determine the taste of coffee, and determine the sample of choice (Asiah *et al*., 2017). According to (Agustina *et al*., 2019), flavor is one of the important factors that can influence consumer decisions to accept or reject a product. The results of Ranitaswari *et al*. 2018 research show that the flavour of a product is a very important criterion because flavor describes the quality of the product.

AHP method helps solve complex problems by compiling a hierarchy of criteria, stakeholders, which are generated by drawing different considerations to develop weights or priorities first. This method can be used to make a consumer preference decision-making system for the taste of Robusta coffee. The different interests and tastes of each consumer are the basis for understanding in developing Robusta coffee. Consumer attitudes towards a product means examining the tendency of consumers to consistently rate a product whether they like it or not.

The Specialty Coffee Association (SCA) is a Specialty coffee association built on the foundation of openness, inclusivity and the power of shared knowledge. SCA's goal is to encourage the global coffee community to support making coffee a more sustainable, equitable and thriving activity for the entire value chain. Specialty coffee has good quality, both taste and aroma with standard cupping tests and processed with special provisions (Maspul, 2023).The objective of this research is to get the preferences of professional coffee testers for Aceh Robusta coffee. This research can be used as a reference for coffee management both in terms of planting location and post-harvest methods.

2. MATERIALS AND METHODS

2.1. Materials

The coffee beans were originated from the districts of Bener Meriah, Tangse, and Lamno harvested 11 months after flowering (Figure 1). In this study, the consumer preferences for Robusta coffee was assessed on the quality parameters based on the Specialty Coffee Association (SCA). The tools used in this research are the super roasting machine, grinding machine, coffee serving equipment, cupping test equipment. Two different processing methods were evaluated, namely wet and dry process. This resulted in six combination treatments. Each treatment per sample requires as much green been Robusta as 1 kg.

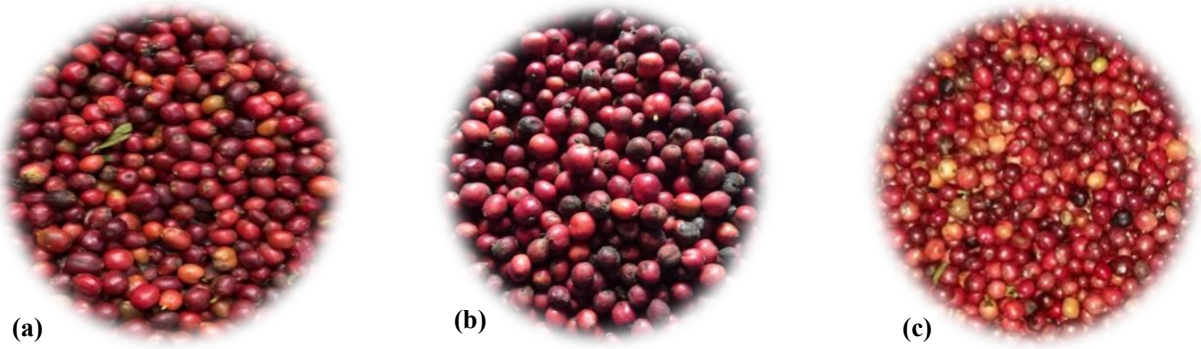

Figure 1. Robusta coffee that has been harvested (a) Bener Meriah, (b) Tangse, (c) Lamno.

2.2. Design of Experiment

The experiment was conducted in order to evaluate three coffee demographic origins (Bener Meriah, Tangse, and Lamno Regencies) and two processing methods (wet and dry). The wet processing begun with peeling the coffee cherries, followed by a 24-hour fermentation process, and then drying. The dry processing involves drying the coffee cherries immediately after peeling without prior fermentation. The only difference between the wet and dry processes is the fermentation process.

2.3. Sensory Assessment

Sensory assessment is a method carried out by humans using the five human senses, namely the eyes, nose, mouth, hands and ears (Rahmawati & Fibrianto, 2019). Through these five basic senses, we can assess the sensory attributes of a product such as color, appearance, shape, taste, and texture and has been widely studied (Bach *et al*., 2012). Sensory testing is conducted to identify sensory differences between each sample, determine the taste of coffee, and determine the sample of choice (Asiah *et al*., 2017). The identified panelists were selected on a number of criteria and have requirements. The requirements for identified as expert panelists based on (Fadhil *et al*., 2021) are as follows: (a) Know the types of Robusta coffee; (b) Like and frequently consume Robusta coffee; (c) Can identify Robusta coffee flavors based on product preference or acceptance; (d) Are willing to become Robusta coffee sensory assessment panelists based on the rules of the research being carried out; and (e) Not in illness that can affect the coffee sensory assessment process, such as cough, flu, mouth ulcers, gastritis and the like.

The coffee sensory assessment process was carried out by dividing the panelists into teams of 2 people, each panelist was given a spoon, mineral water, coffee container, and questionnaire paper. Before starting to assess the taste of Robusta coffee, the panelists filled in their personal data, and continued with an explanation of the order of filling out the questionnaire. The process of serving Robusta coffee was carried out simultaneously by directly serving 12 samples of Robusta coffee brewed with SCAA protocol way. Cupping test was conducted following the experiment for AHP Analysis where professional coffee tester preferences were tested for six combinations of origins × processing methods. Cupping tests for coffee involves several parameters commonly used for cupping tests including Aroma, Flavor, Aftertaste, Acidity, Bitter/Sweet, Mouthfeel/Body, Balance, Uniform Cup, Clean Cup and Overall. Preparation of coffee ground samples followed the Specialty Coffee Association of America (SCAA) protocol for sample preparation of coffee cupping test.

Aroma or Fragrance was identified as the smell of freshly ground coffee while it is still dry and the smell of coffee when infused with hot water and steam is released. Flavor was identified as a combination of what is felt on the tongue and the aroma of steam in the nose that flows from the mouth to the nose. The value given to flavor must include the influence, quality, and complexity of the combination of taste and aroma when the coffee is sipped into the mouth strongly so that it involves the entire palate in assessing. Aftertaste is defined as the duration of the positive taste quality that originates from the back of the palate and remains after the coffee is swallowed. Acidity is often described as a distinctly sour taste that is pleasant or sour if unpleasant. Body is the heavy/thick or light feeling of a liquid in the mouth, especially felt between the tongue and the roof of the mouth. It is resulted from dissolved solids and oils suspended in the liquid. Sweetness is the presence of a pleasant sweet taste because coffee contains carbohydrates. The opposite of sweetness is bitterness. Uniformity is the uniformity of aroma and taste of each bowl.

If the aroma of a cup is different, then the value for this criterion is low. A value of 2 is given to each different cup and the total value of 5 for the cup is 10. Clean cup shows no negative values from the beginning in terms of Taste to Aftertaste. Balance is all aspects of Flavor, Aftertaste, Acidity, and Body that are balanced in the example called balance. If one aspect is lacking or exceeding in the example, the balance value will decrease. In other words, balance is the absence of a dominant Taste or Aroma. Overall is an assessment that reflects the overall aspects of a coffee sample as felt by each panelist.

2.4. Scoring

Scoring was done by experts who have been certified as Q-Graders so that they have been trained to quantify attribute values such as Fragrance/Aroma, Flavor, Aftertaste, Acidity, Body, Balance, Uniformity, Clean Cup,

Sweetness, and Overall correctly because they have undergone training and competency tests. Overall scoring was based on the taste experience of individual cuppers as a personal assessment that has received training. The quality was classified based on score as presented in Table 1.

Table 1. Quantification cupping attributes (SCAA, 2018)

Quality	Score
Good	5 – 6.75
Very Good	7 – 7.5
Excellent	8 – 8.75
Outstanding	9 - 10

2.5. Data Analysis

The data were analyzed using the Analytical Hierarchy Process (AHP) method, which is a complex problem-solving method contained in a hierarchical diagram where the objectives, factor levels, criteria, sub-criteria levels, up to the final level and alternatives. The following is a hierarchical structure for determining the flavor of Robusta coffee originating from Bener Meriah, Tangse, and Lamno districts.

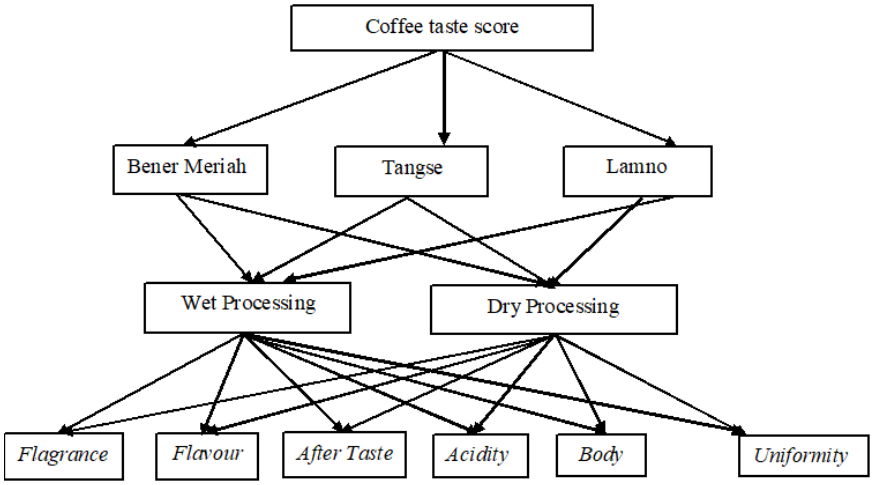

Figure 2. Sensory hierarchy structure of Robusta coffee flavor using the AHP method

3. RESULTS AND DISCUSSION

3.1. Robusta Coffee Processing

In about 2.5 years, Robusta has begun to be harvested, although the results are not optimal. To bear fruit well, this type of Robusta coffee requires 3-4 months of heat a year with several rains which are harvested every 15 days. Robusta fruit is round in shape and tends to be dark red in color. Robusta fruit sticks firmly to the stem even though it is ripe. Robusta coffee yield is quite high, around 22%. Robusta coffee growth ideally at an altitude of 400-800 meters above sea level (Feria-Morales, 2002).

This study uses 2 processing methods namely wet processing and dry processing. The wet processing is carried out in several stages, namely the process of stripping the outer shell of Robusta coffee beans which aims to separate the beans from the outer shell to obtain Robusta coffee beans that are still wrapped by the horns. Furthermore, a fermentation process is carried out whose function is to reduce acid levels in coffee beans, the third stage is washing the coffee beans which is carried out to remove all layers of mucus that is still left during the fermentation process, and the fourth stage is the drying process or drying coffee beans that have been washed and carried out drying. Manually dried in the sun, this drying process is carried out until the skin of the horns of the dried Robusta coffee

beans looks dry. The fifth stage is milling or peeling the HS skin, the sixth stage is sorting the beans and the final stage is drying the rice coffee to a moisture content of 12%. Likewise, in dry processing, the coffee cherries enter the drying stage directly without peeling the fruit skin and washing it. The first stage in roasting coffee is green beans or raw coffee beans put into the roasting machine and then roast the green beans until the coffee changes color gradually, from green to yellow, then brownish yellow, then light brown, dark brown, blackish brown , until the last one turns black. Medium roast has a coffee bean temperature in the range of 210°C and 220°C. At this temperature, it is the temperature at which the first crack ends but the second crack has not occurred (Pereira *et al*., 2017).

3.2. Cupping Score Assessment Test

Cupping was carried out based on 11 assessment attributes assessed by 3 professional cuppers (Q-Graders) from the Gayo Cuppers Team on 6 samples from Bener Meriah, Tangse and Calang districts. The assessment of the 6 samples can be seen in Table 2. With this method cuppers are highly trained to identify and understand the sensory aspects that determine the quality of coffee in the cup (Feria-Morales, 2002). The cupping test assessment in Table 1 shows the variation of the final score obtained by each sample. Of the 6 samples of Robusta coffee analyzed, the best final score was found in the Wet Processing Lamno coffee sample with a final score of 75.25, followed by the Dry Processing Lamno coffee sample, which was 73.25, the Bener Meriah dry processed coffee sample and the Wet Processed Tangse coffee 68.75, the Bener coffee sample The celebration of Wet Processing and Dry Processing Tangse is 68.50. From the results of the Q-Grader which has the highest score, coffee comes from calang with a wet processing process, because the assessment is at a score of 75.25 the coffee is said to be very good coffee. Light fluid in the mouth, especially felt between the tongue and the roof of the mouth. The reason for the cupping test is to find out the true taste of each sample. Because each type of coffee has several different characteristics. The sum of the individual scores of all attributes assessed by the cupper represents the overall quality of the coffee itself (Toledo *et al*., 2016).

Table 2. Score resulted from cupping test for coffee from three areas with two processing methods by Q-Grader

Attribute	Bener Meriah		Tangse		Lamno	
	Dry Processing	Wet Processing	Dry Processing	Wet Processing	Dry Processing	Wet Processing
Aroma	6.25	5.50	5.75	5.50	5.25	6.00
Flavor	6.00	5.75	5.50	5.75	6.25	6.25
Aftertaste	6.00	6.00	6.25	6.00	6.50	6.75
Salt/Acid	6.00	6.00	6.00	6.00	6.50	7.00
Bitter/Sweet	5.00	5.50	5.50	6.00	7.00	7.00
Mouthfeel/Body	8.00	7.75	8.00	8.00	8.00	8.00
Balance	5.50	6.00	5.50	5.50	6.75	7.00
Uniform Cup	10.00	10.00	10.00	10.00	10.00	10.00
Clean Cup	10.00	10.00	10.00	10.00	10.00	10.00
Overal	6.00	6.00	6.00	6.00	7.00	7.25
Final Score	**68.75**	**68.50**	**68.50**	**68.75**	**73.25**	**75.25**

Performing a taste test by cupping test has a certain protocol in assessing a cup of coffee to be tested based on the provisions of the SCAA (Specialty Coffee Association of America), where the sample must first be visually inspected for roast color. These are marked on the sheet and can be used as a reference during the assessment of certain taste attributes. The order of assessment of each attribute is based on changes in taste perception caused by a decrease in coffee temperature when cooled (Lingle & Menon, 2017). The quality of coffee drinks is based on the "cupping test," the international standard recommended by the Specialty Coffee Association of America (SCAA) for the classification of coffee drinks (Lingle, 2011).

3.3. Robusta Coffee Ranking Results

Pairwise comparisons on the criteria and sub-criteria determination in this case give the weight or value of the level of importance of each pair of criteria and sub-criteria with the Saaty scale. To be able to provide a value of importance

that is in accordance with the determination of the taste characteristics of Robusta coffee in the 3 regions, further studies of the data are carried out. The following is the value of the importance of the criteria for determining the taste of Robusta coffee from Bener Meriah, Tangse and Lamno. Table 3 is the result of alternative pairwise comparisons obtained by the value of the multiplication of 9 respondents.

Table 3. Alternative pairwise comparison

Alternative	Aroma	Flavour	Aftertaste	Acidity	Body	Uniformity
Aroma	1	0.28	0.75	0.42	0.38	0.65
Flavour	3.61	1	4.31	2.36	3.38	1.82
Aftertaste	1.82	0.23	1	0.72	1.41	2.4
Acidity	2.37	0.42	1.19	1	1.23	0.97
Body	2.61	0.3	0.61	0.56	1	0.45
Uniformity	1.54	0.55	0.41	1.04	2.27	1

Table 4. Alternative column normalization results

Alternative	Fragrance/Aroma	Flavour	Aftertaste	Acidity	Body	Uniformity	Total
Fragrance/Aroma	0.08	0.10	0.09	0.07	0.04	0.09	0.08
Flavour	0.28	0.36	0.52	0.39	0.35	0.25	0.36
Aftertaste	0.14	0.08	0.12	0.12	0.15	0.33	0.16
Acidity	0.18	0.15	0.14	0.16	0.13	0.13	0.15
Body	0.20	0.11	0.07	0.09	0.10	0.06	0.11
Uniformity	0.12	0.20	0.05	0.17	0.23	0.14	0.15
Eigenvector							1.00

In finding the priority vector and eigenvector values for the criteria and sub-criteria, from the pairwise comparison table, column normalization is carried out to get the priority vector and eigenvector values by dividing each value in the table column by the number of each value in the table column. The following are the results of normalization of Table 2 which are shown in Table 4. It shows the results of the normalization value or the eigenvalue, the results for the Aroma criteria with Aroma (0.08) is the least one and the highest is eigenvalue in Flavour with Flavour.

After obtaining column normalization for each of the values in Table 4, in finding the priority vector the next step is to add up all the values in the rows of Table 3 and the results of the summation of these rows will be divided by the number of determination criteria used. In this case, the total to determine the taste of Robusta coffee from various regions is 6. Then the sum of the values for each row of Table 4 will be divided by 6. Before the Priority vector value can be used as a determination, it is necessary to know the consistency index (CR), if the consistency index is less than 0.1 then it is consistent and if more than 0.1 then it is inconsistent. The eigenvector or weight of each criterion varies (Table 5). Among them, Fragrance/Aroma has a weight of 0.08, Flavor has a weight of 0.36, Aftertaste has a weight of 16, Acidity has a weight of 0.15, Body has a weight of 0.11, and Uniformity has a weight of 0.15. The weight is determined by the respondent based on the respondent's perception of the most influential criteria or the level of importance of enjoyment in a cup of coffee from the 6 criteria. The greater the eigenvector value/weight, the better.

Table 5. Priority vector criteria

Criteria	Bener Meriah		Tangse		Lamno	
	Wet Processing	Dry Processing	Wet Processing	Dry Processing	Wet Processing	Dry Processing
Bener Meriah Wet Processing	0.10	0.07	0.03	0.09	0.54	0.17
Bener Meriah Dry Processing	0.14	0.09	0.04	0.06	0.36	0.31
Tangse Wet Processing	0.25	0.20	0.10	0.04	0.20	0.22
Tangse Dry Processing	0.24	0.13	0.21	0.08	0.29	0.14
Lamno Wet Processing	0.08	0.10	0.20	0.12	0.41	0.09
Lamno Dry Processing	0.08	0.04	0.05	0.15	0.56	0.12
Amount	**0.13**	**0.10**	**0.11**	**0.09**	**0.39**	**0.17**
Average	**0.02**	**0.02**	**0.02**	**0.02**	**0.07**	**0.03**

The steps in determining the eigenvector are the same as the steps taken in determining the priority vector where the first step is to normalize the column for each column value in the table and then divide the number of rows from the column normalization results with the total criteria used. For the average results of the criteria for Bener Meriah Wet Processing, Bener Meriah Dry Processing, Wet Processing Tangse, Dry Processing Tangse obtained worth 0.02, Wet Processing Lamno 0.07, and 0.03 Dry Processing Lamno.

Table 6 is a table of the results of the calculation of the ranking of criteria from the existing sample data, where coffee from Lamno Wet Processing with a value of 0.0429 has the highest value or is in the Grade 1 position. Bener Meriah Dry Processing is the second highest value, the third highest value is in Lamno Dry Processing, Wet Processing Tangse is the fourth highest value, Dry Processing Tangse is the fifth highest value and Bener Meriah Wet Processing has the lowest value of the three regions with 2 existing treatments.

Table 6. Ranking of Robusta coffee flavors originated from three regencies in Aceh

Area and Processing Type	Score	Persentase	Ranked
Bener Meriah Dry Processing	0.036	25%	2
Bener Meriah Wet Processing	0.0104	7%	6
Tangse Dry Processing	0.0135	9%	5
Tangse Wet Processing	0.0176	12%	4
Lamno Dry Processing	0.0255	18%	3
Lamno Wet Processing	0.0429	29%	1

The results of the coffee taste test on each treatment were identified to obtain slightly different results from the results of the cupping test on expert respondents (Q Grader). In the results of the taste test on respondents, the best coffee based on ranking using the AHP method is in wet processing Lamno coffee which has a preference value of 0.0429 mean lamno coffee highest obtion to choose by expert panelist. From these results, it is in accordance with the cupping test assessment and the taste test assessment which lies in the assessment of the best coffee, namely wet processing Lamno coffee with a total cupping score of 75.25. However, there are some results that are not in accordance with the cupping test results, where Bener Meriah coffee dry processing is ranked 2nd in the taste test of the identified respondents, while in the cupping test assessment of dry processed Bener Meriah coffee has a score of 68.75 which is ranked the 3rd. In the taste test of respondents, it was identified that dry processed Lamno coffee was ranked 3rd, while in the cupping test, dry processed Lamno coffee was ranked 2nd with a score of 73.25. In the taste test of respondents, it was identified that the wet processed Tangse coffee was ranked 4th, while in the cupping test, the wet processed Tangse coffee was ranked 3rd with a score of 68.75. In the taste test of respondents, it was identified that dry processed Tangse coffee was ranked 5th, while in the cupping test dry processed Tangse coffee was ranked 4th with a score of 68.50 and similarly, wet processed Bener Meriah coffee was ranked 4th. With a score of 68.50 and in the taste test of respondents, it was identified that wet processed Bener Meriah coffee was in the 6th rank with the lowest value.

This value is slightly different from the cupping test assessment, due to differences in the views of the assessment between expert respondents (Q-Graders) and identified respondents. Where the Q-Grader in assessing coffee based on the level of taste produced on the quality of the distinctive characteristics possessed by Robusta coffee from 3 regions with 2 treatments themselves, namely the taste of coffee which has a characteristic, one of which is a slightly bitter or sharp taste with a taste character like wood and rubber. The cupping assessment is intended to determine the quality of the taste of the coffee produced before distribution is fine or specialty coffee that has gone through special test stages and has been approved (Musika, 2020).

4. CONCLUSIONS

Based on the cupping test of Robusta coffee taste assessment conducted by expert respondents on the six samples, it was found that the best coffee was Lamno Wet processing coffee with a total score of 75.25. Based on the assessment of the taste of Robusta coffee conducted by the identified respondents, the best value was obtained in the Wet Processing Lamno coffee sample which had a preference value of 0.0429. And the most important criteria that must be

considered when determining the priority of Robusta coffee taste so that it can be accepted by consumers or panelists are Flavor with a weight of 0.36, then Aftertaste 0.16, Acidity and Uniformity 0.15, Body 0.11, and Fragrance or Aroma 0.08.

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