COFFEE SCIENCE
ISSN: 1984-3909

eISSN: 1984-3909
Coffee Science, e182085, 2023

Doi: https://doi.org/10.25186/.v18i.2085

Study of variations in the roasting time of gayo arabica coffee in the drying phase

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Received in November 9, 2022 and approved in April 5, 2023

ABSTRACT

Gayo Arabica coffee is a famous specialty coffee in Indonesia and abroad. Proper roasting is needed to produce high-quality coffee, including getting the desired coffee taste. This study contributes to roasting high-quality coffee, especially regarding the appropriate time variation in the drying phase. This study aims to analyze the roasting time of Gayo Arabica coffee in the drying phase based on the cupping score and sensory assessment. Coffee roasting in this study was carried out by modifying the time in the drying phase for 3:00, 4:00, and 5:00 minutes, while in the other phases (maillard and development), it was 4:00 and 3:00 minutes, respectively. The study parameters include roasting charts which measure the time for drying, maillard, development and total roasting time, roasting profiles, cupping scores by certified panelists (Q graders) and sensory assessments by identified panelists by the TOPSIS method. The TOPSIS is a decision-making method based on various alternatives that are ranked to get the best results with the highest value. The results showed that the best time treatment in the drying phase based on the cupping score was the F2 treatment as rank 1 (score 85.00), treatment F1 as rank 2 (score 83.50), and treatment F3 as rank 3 (score 81.00). Meanwhile, the sensory assessment by the panelists using the TOPSIS method showed the same thing for rank 1, namely the F2 treatment with a value of 0.88. However, it is different for rank 2, namely the F3 treatment with a value of 0.69 and ranks 3 is the F1 treatment with a value of 0.17. It can be concluded that the assessment by certified and identified panelists, who can be considered representative of consumers, show the same conclusion that coffee roasted with the best treatment in the drying phase is 4 minutes (F2).

Key words: Cupping score; drying phase; identified panelists; TOPSIS method; Q grader; roasted.

1 INTRODUCTION

Gayo Arabica coffee is one of Indonesia's specialty coffees because of its high taste and uniqueness (Fadhil; Nurba, 2019). This coffee grows in highland areas, including the Aceh Tengah, Bener Meriah and Gayo Lues regencies, where most people depend on their income from coffee plantations (Fadhil et al., 2018b; Rahmaddiansyah et al, 2022). In 2012, the Gayo Arabica coffee cultivation area received a Geographical Indication (GI) certification. The certification acknowledges the Gayo highland area, categorized as a Gayo Arabica coffee producer (Fadhil et al., 2018a). Most Arabica coffee cultivation lands are plantations owned by the community, with land ownership of 1-2 hectares per family (Fadhil; Nurba, 2019; Fadhil; Safrizal; Muhir, 2022).

Coffee has a high economic value than other plantation commodities and is also an important source of foreign exchange earnings. The selling value of coffee is also a major source of income for some communities, approximately 1.5 million farmers in Indonesia are coffee farmers (Ngabito; Baruwadi; Indrianim, 2021). The increase in coffee production and quality in Indonesia should be continuously improved therefore can compete in the world market. In obtaining high-quality coffee, the main thing needed is handling and determining the height of the coffee cultivation area. Gayo Arabica coffee can grow well at 1,000-1,700 meters above sea level (Gayo; Rusdi; Fazlina, 2018; Fadhil; Sulaiman; Farhan, 2022).

In order to get high-quality coffee beans, it is necessary to carry out proper and structured post-harvest handling. Roasting is important in producing high-quality coffee products (Kaswindi; Bambang; Rita, 2017). The roasting process is one of the essential stages in coffee processing because this process is the stage of forming the taste and aroma of coffee beans. According to Fadri (2019), the determinants of taste in coffee can be categorized into several stages, 30% by the roasting process, 60% from the cultivation process to post-harvest, and 10% during coffee brewing by the barista.

In the coffee roasting process, there are three decisive time phases: the drying phase, the maillard phase, and the development phase. The drying phase is a process starting with charge temperature (initial temperature), turning point (temperature decrease), decreasing water content and equilibrium. The drying phase ends when it has entered the maillard phase, marked by the yellowing process, therefore it starts after the drying phase is complete. The maillard phase starts with yellowing, bread aroma, and the first crack. Then, the development phase starts from the first crack and ends (drop) (Choo, 2019). The drying process of green coffee beans may be accompanied by changes in the physical, chemical, and organoleptic properties of heat-sensitive components. The drying process did not affect the caffeine content, but it influenced the concentration of histidine, as in the present study. In addition, significant differences were observed for aspartic acid and phenylalanine. The harvest period and drying

type cannot be used as cupping predictors since no clear trends were observed to classify specialty coffee organoleptic attributes. Therefore, other variables involved in specialty coffee processing should be explored to evaluate higher sensitivity toward flavor prediction and innovation (Arévalo, 2023).

The TOPSIS method, known as the Technique for Orders Preference by Similarity to Ideal Solution, is used for multi-criteria decision-making. This method was first introduced by Hwang and Yoon (1981), with the rule that the chosen alternative should have the closest distance to the solution from the positive ideal and be far from the negative ideal solution. The alternatives in this method are sorted based on the resulting values; therefore, the alternative with the closest distance to the positive ideal solution should be used or recommended (Fadhil; Agustina, 2019; Juliyanti; Mohammad; Imam, 2011). The use of the TOPSIS method has developed widely in various fields related to decision-making, such as Upu (2016), Pramudhita, Suyono and Yudaningtyas (2015), Babak, Abdullah and Pelin (2020), Li, Jianming and Yiyu (2020), Shouzhen, Shyi and Kang (2020). According to the TOPSIS technique, the most preferred alternative will be the one nearest to the positive-ideal solution and farthest from the negative-ideal solution. The positive-ideal solution maximizes the benefits criteria and minimizes the cost criteria. The negative-ideal solution greatly increases the cost criteria and minimizes the benefit criteria. To summarize, the positive-ideal solution consists of all of the best values of the criteria, while the negative-ideal solution consists of all the worst values of the criteria (Mubarak et al., 2021). TOPSIS is an effective and widely used numerical method of multicriteria decision-making. Its application is broad and uses a simple mathematical model. It is also a suitable practical method because it relies on computer usage (Liang et al., 2017).

This study analyzed the Gayo Arabica coffee roasting time variation in the drying phase based on the cupping score and sensory assessment. This study will contribute to finding the best time in drying the Gayo Arabica coffee roasting process. Thus, it can be used as a reference to produce high-quality coffee flavors.

2 MATERIAL AND METHODS

2.1 Design

This study was conducted at PT. Aromabica Gayo International, Aceh Tengah Regency and Post-Harvest Engineering Laboratory, Universitas Syiah Kuala, Banda Aceh. The tools and materials used include a roasting machine for the Super Roaster Type: Horizontal Centrifuge Batch, artisan software, digital scales, stopwatches, glasses, spoons, measuring cups and cameras. Then, the material used is full-wash Arabica coffee beans taken from Blang Gele Village, Bebesen District, Aceh Tengah regency, as much as 6 kg with a moisture content of 10.25%.

The procedure in this study uses four stages. The first is the roasting process. The second is the determination of the roasting profile using the Agtron scale. The third is the cupping score assessment of the roasting results by a certified panelist (Q grader). Then, the fourth is the sensory assessment of the roasting results by the identified panelists using the TOPSIS method for decision-making from 3 time-treatments in the drying phase.

2.2 Roasting Process

Gayo arabica coffee beans which processed in fullwash were roasted for three treatments, where each treatment used 2 kg of beans. Before the coffee beans are roasted, the initial stage is measuring the density to determine the appropriate time before putting them into the roasting machine. Then, the arabica coffee is put into the Super Roaster Type: Horizontal Centrifuge Batch machine with a constant initial temperature of 170 °C with a gas pressure of 3 Psi. When the coffee beans are added, the artisan software is activated, therefore, the graph can be seen when the green beans are roasting. A stopwatch is prepared as a marker of the roasting time, starting from the drying phase (early phase), the maillard phase and ending in the development phase. After completing the roasting process, a curve graph is obtained for each treatment sample. Based on the graph, the temperature transfer process from the beginning to the end of the roasting process for each sample can be observed.

The main key in carrying out the roasting technique in this study is following the previous study from Copper (2017). According to Copper (2017) and Choo (2019), the optimal time of the roasting process is in the drying phase, 0:00 – 05:00 minutes. This is also based on the roasting results from the World Coffee Roasting Championships, Jack Allisey (2017) and Arseny Kuznetov (2019). They stated that the optimal drying phase was at 0:00-5:00 minutes, the flavor formation phase (maillard) at 5:00 – 8: 30 minutes and the development phase at 9:30 – 10:00 minutes, as normal for the roasting.

This study's variation in drying phase time included F1 treatment for 3:00 minutes, F2 treatment for 4:00 minutes, and F3 treatment for 5:00 minutes. However, the maillard and development phases are not varied, only determined at the maillard phase of 4:00 minutes and the development phase of 3:00 minutes (Table 1). The time of the maillard and the development phase are based on the initial trial of the study.

2.3 Roasting Profile

After the roasting process, the coffee beans are matched with the Agtron scale to determine the roasting

profile produced. The Agtron scale will be a reference for roasting profile markers at a certain level, such as light, light to medium, medium, medium to dark or dark.

Table 1: Treatment of the Roasting Phase.

Roasting Phase Treatment				
Treatment	Drying (minute)	Maillard (minute)	Development (minute)	Total Roasting time (minute)
F1	3:00	4:00	3:00	10:00
F2	4:00	4:00	3:00	11:00
F3	5:00	4:00	3:00	12:00

2.4 Cupping Quality

The cupping score is an assessment carried out by a certified panelist (Q grader) or a group of trained panelists who already have an SCA (Specialty Coffee Association) certificate. This expert panelist has professional coffee taste buds with testing rules following the Specialty Coffee Association of America (SCAA) standards. The cupping score test in this study was carried out by panelists from the Gayo Cuppers Team (GCT).

2.5 Sensory Assessment

A sensory assessment is an assessment by a panel of coffee connoisseurs and drinkers who can be considered representatives of consumers. This sensory assessment is selected based on certain identification, referred to as identified panelists. The identification of these panelists includes (Fadhil; Nurba; Sukmawati, 2021; Fadhil; Sulaiman; Farhan, 2022):

a) Knowing the types of coffee
b) Likes and often consumes Gayo Arabica coffee
c) Can identify the taste of Gayo Arabica coffee
d) Willing to be a panelist for the sensory assessment of Gayo Arabica coffee based on the study principles carried out
e) In good condition. Because coughs, flu, canker sores, ulcers, and the like will affect the coffee sensory assessment process.

Sensory assessment is carried out by nine panelists identified. The sensory assessment criteria included flavor, aroma, aftertaste, acidity, and body. Then, the panelists determine preference level using a scale of 1-5 as an assessment parameter. Scale 1 is the lowest level of preference and Scale 5 is the highest level of preference.

2.6 TOPSIS method

The TOPSIS method was used to decide on the acceptance of roasted products by identified panelists. This method is widely used to complete practical decision-making. This is because the concept is simple, easy to understand, computationally efficient, and can measure the relative performance of decision alternatives (Marbun; Sinaga, 2018; Hasan et al., 2012). The stages of the TOPSIS method are as follows (Ginting et al., 2017):

1. The initial stage in the TOPSIS method is to create a decision matrix. In Equation 1, the decision matrix with the symbol X refers to *m* as an alternative that will be evaluated based on *n* as the criterion. The alternatives in this study are various treatment time, while the criteria are sensory coffee.

$$X = \begin{matrix} a_1 \\ \vdots \\ a_m \end{matrix} \begin{pmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{pmatrix} \quad (1)$$

2. The second stage is to create a normalized decision matrix. Equation 2 is used to convert each element x_{ij}:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}\,2}} \quad (2)$$

3. The third stage is to create a normalized and weighted decision matrix. Where the weight $w_i = (w_1, w_2, w_3, ..., w_n)$ and w_j is the weight of the jth criteria and $\sum_{j=1}^{n} w_j = 1$, therefore the normalization of the matrix V weights is as follows:

$$v_{ij} = w_j\, r_{ij} \quad (3)$$

4. The fourth stage is determining the matrix of positive and negative ideal solutions. A^+ symbolizes the positive ideal solution, and the negative ideal solution is symbolized by A^-. Then, the equation of A^+ and A^- are as follows:

$$\begin{aligned} A^+ &= \{(\max v_{ij} \mid j \in J), (\min v_{ij} \mid j \in J'), i = 1, 2, 3, ..., m\} \\ &= \{v_1^+, v_2^+, v_3^+, ..., v_n^+\} \\ A^- &= \{(\min v_{ij} \mid j \in J), (\max v_{ij} \mid j \in J'), i = 1, 2, 3, ..., m\} \\ &= \{v_1^-, v_2^-, v_3^-, ..., v_n^-\} \end{aligned} \quad (4)$$

5. The fifth stage is calculating the separation.

$$\begin{aligned} S_i^+ &= \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2}, \text{with i} = 1, 2, 3, ..., \text{m} \\ S_i^- &= \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2}, \text{with i} = 1, 2, 3, ..., \text{m} \end{aligned} \quad (5)$$

6. The sixth stage is calculating the relative closeness to the positive ideal solution.

$$c_i^+ = \frac{S_i^-}{(S_i^- + S_i^+)}, 0 \le c_i^+ \le 1 \quad (6)$$

7. The last stage is ranking the alternatives of C_i^+ value from the largest to the smallest. Then, the best solution is an alternative with the biggest value of C_i^+.

3 RESULTS

The water content used in this study was 10.25%, and the density of the beans was 750 grams/liter with an initial temperature of ±170 °C and 2 kg coffee beans/treatment. According to Kinge (2018), determining water content and seed density is very important to get optimal roasting results and avoid bad effects when using the roasting technique. If the water content and density of the beans are unknown, it can cause unwanted roasting results, such as the beans can burn faster when the desired roasting time or profile does not occur. Then, the determination of beans density before the roasting technique can be seen in Table 2.

3.1 Roasting Graphic

The roasting graph is a standard for roasters to see which roast is the best based on the results of the previous roasting technique. The roast chart can also be used as an initial image when the roaster wants to mix a new roast.

The final temperature refers to Table 2 (Choo, 2019), where there is a range based on the density of coffee which is measured at the beginning before roasting is carried out. If the initial density of coffee beans is medium (651-700), then the final temperature is selected in the range 185-195, with a Roast level of Light to Medium. The first crack indicates coffee maturity has occurred, usually do not have to wait for the next crack. Gayo Arabica coffee roasters will usually stop some time after the first cracking.

Each of the graphs in Figure 1, Figure 2, and Figure 3 has green color as a symbol of BT (beans temperature) and a bright blue curve line as a symbol of ΔBT (delta beans temperature). It shows ROR (Rite of Rise); how many degrees the temperature of the coffee beans will rise or fall during the roasting process. Measurement of changes in the coffee beans' temperature on the ROR (Rite of Rise) occurs 30 seconds after the roasting process starts.

The results of the graph in Figure 1, when the roasting process begins, show the initial temperature in the F1 treatment in the BT graph with the use of constant heat at a temperature of 168.6 °C. This is a normal temperature during the roasting process. The initial roasting temperature was obtained from the density of the beans in Table 1. The temperature of ±170 °C on the treatment chart was obtained from the density level of 750 grams/liter. According to Choo (2019), if the density of coffee beans during measurement gets a light density value, the initial temperature during the roasting technique should be low. Meanwhile, if the density of the coffee beans is very heavy, the initial roasting temperature should be high.

After the coffee beans are added, a turning point (TP) occurs at minute 1:18 with a temperature of 101.8 °C, followed by the end of drying (drying phase), namely dry end (DE) at minute 3:00 with a temperature of 137.3 °C. Then, entering the maillard phase until the first crack occurs at 7:00 minutes with a temperature of 187.3 °C and continues with the development phase until it reaches the drop point or seeds are removed at 10:00 minutes with a temperature of 209.5 °C. The increase in temperature (ΔBT) or Rate of Rise (ROR) in Figure 1 occurs when the turning point progresses to the drop point, which indicates that the heat in this treatment is constant or there is no significant increase. The ROR process in the F1 treatment shows that the coffee beans' temperature looks normal because it continues to decrease until the end of the coffee beans being removed from the roaster machine.

Figure 2 shows the roasting process in the BT graph's initial temperature in the F2 treatment, starting with constant heat at a temperature of ±170 °C. Then, it continues at 1:15 minutes when the turning point (TP) occurs with a temperature of 101.5 °C and ends at the drying phase or the dry end (DE) at minute 4:00 at a temperature of 157 °C. Then, the maillard phase entered the first crack at 8:00 minutes with a temperature of 196.8 °C and continued with the development phase until it reached a drop point at 11:00 minutes with a temperature of 213.6 °C. The increase in temperature (ΔBT) or ROR in Figure 2 occurs when the turning point progresses to the drop point, which indicates that the heat in this treatment is constant or there is no significant increase. The ROR process in the F2 treatment shows that the coffee beans' temperature looks normal because it continues to decrease until the end of the coffee beans is removed.

Table 2: Density measurement to determine the initial roasting temperature

Bean Density & Roast Level					
Density Level	Density gram/ liter	Initial Temperature (°C)	Final Temperature (°C)	Recommended Roast Level	
				Agtron Scale	Roast Level
Low	< 650	150	180 – 190	75 - 65	Very – light to medium-light
Medium	651 - 700	160	185 – 195	70 - 58	Light to medium
High	701 - 750	170	190 – 205	65 - 55	Medium-light to medium-high
Very High	>750	190	200 – 220	60 - 45	Medium-light to dark

Source: Choo (2019).

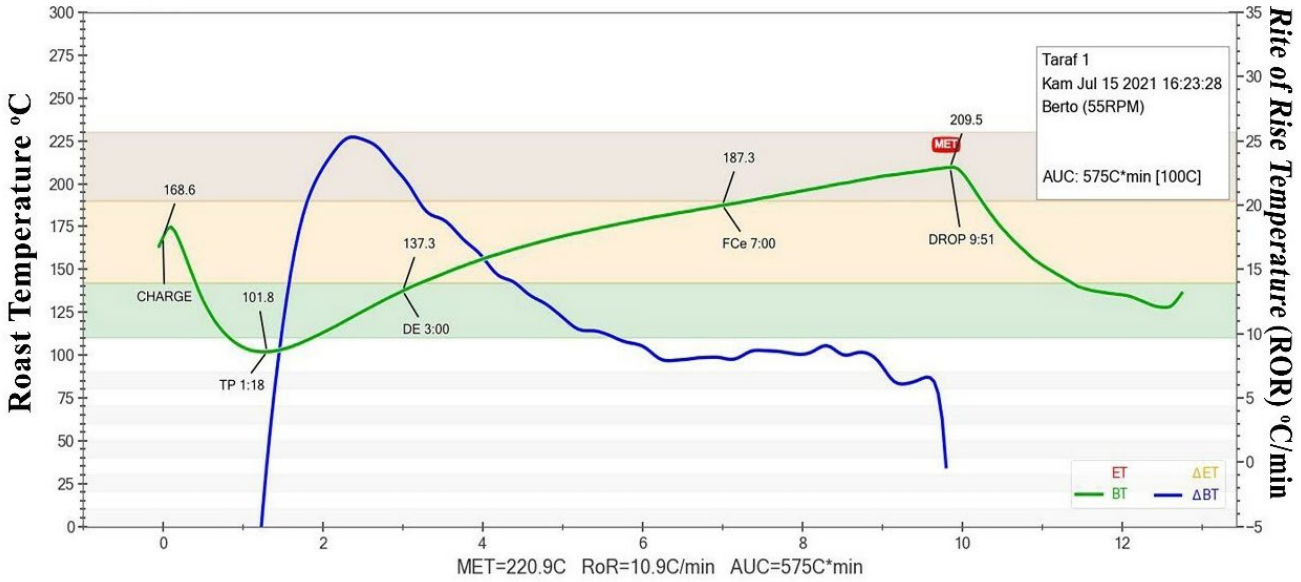


Figure 1: The roasting graph of F1 treatment, namely drying phase 3:00 minutes, maillard phase 4:00 minutes and development phase 3:00 minutes.

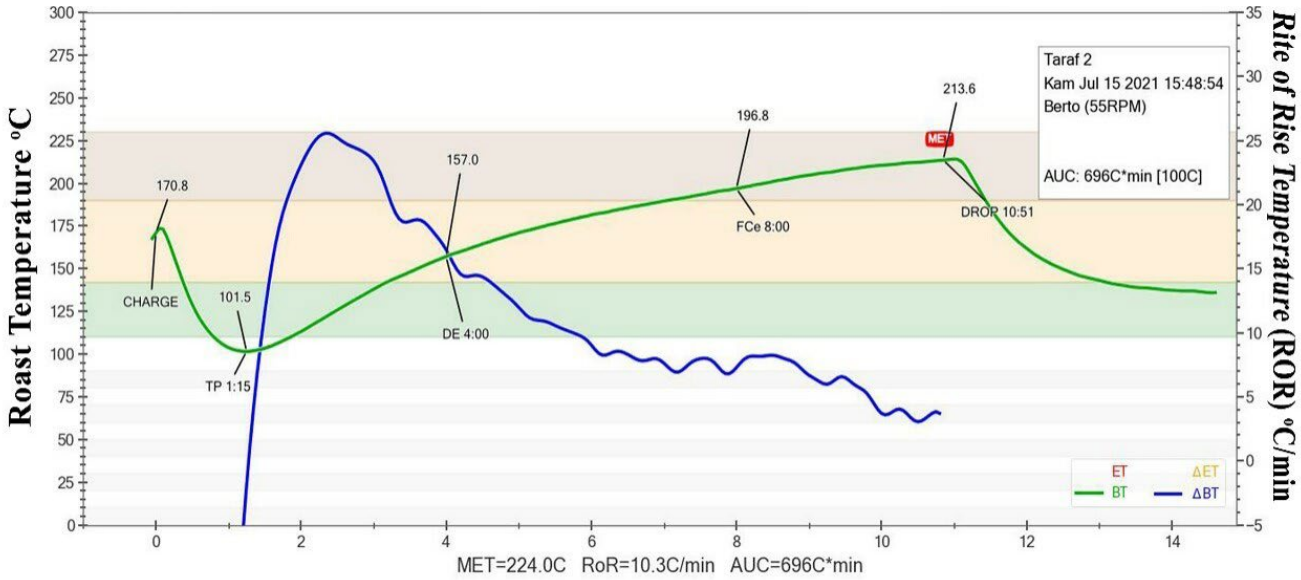


Figure 2: The roasting graph of F2 treatment, namely drying phase 4:00 minutes, maillard phase 4:00 minutes and development phase 3:00 minutes.

Figure 3 shows the initial temperature of the roasting process in the F3 treatment in the BT graph. It starts with a constant heat at a temperature of ±170 °C, followed by 1:15 minutes of turning point (TP) with a temperature of 102.8 °C. The end of the drying phase, namely the dry end (DE) at 5:00 minutes with a temperature of 173.9 °C. Then, the entry of the maillard phase until the first crack at 9:00 minutes with a temperature of 209.2 °C continued with the development phase until it reached the drop point at minute 12:00 with a temperature of 223.4 °C. The ΔBT or ROR in Figure 3 occurs when the turning point progresses to the drop point, which indicates that the heat in this treatment is constant or there is no significant increase. The ROR process in the F3 treatment shows that the coffee beans' temperature looks reasonable, which continues to decrease and increase slightly due to the wind and changes in room temperature. Turning Point in F1 at 1 minute 18 seconds, while F2 and F3 together at 1 minute 15 seconds. So Phases F2 and F3 have the fastest turning points.

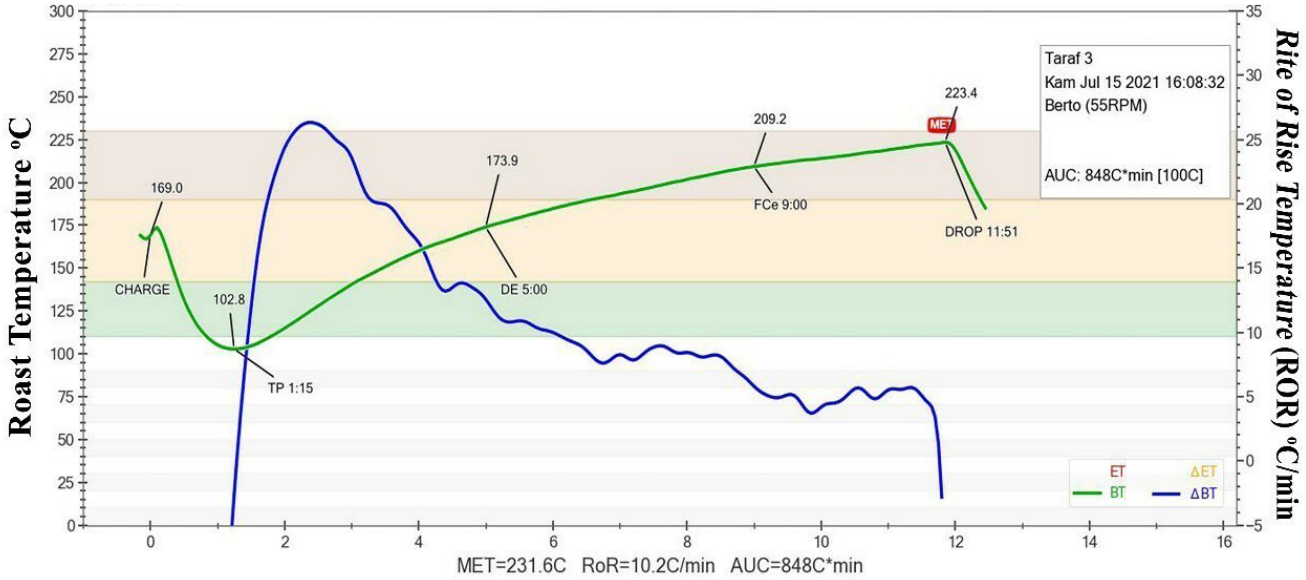


Figure 3: The roasting graph of the F3 treatment, namely the drying phase at 5:00 minutes, the maillard phase at 4:00 minutes and the development phase at 3:00 minutes.

3.2 Roasting Profile

A roasting profile is a roasting level. The longer the roasting process, the darker the color of the roasting profile and the faster the roasting process, the brighter the color of the roasting profile. The roasting profile assessment uses the Agtron scale, where its classification has eight roasting levels, very light, light (American roast), moderately light, light medium, medium, moderately dark, dark, and very dark (French roast) (Massey, 2016). Based on the test results obtained, the first treatment (F1) has a score of #65 (light-medium), the second treatment (F2) is #55 (medium), and the third treatment (F3) is #35 (dark) (Figure 4).

In this study the different length of drying phase will prolong the roasting process, thats the reason of the color of coffee are darker for F3 than F1. The longer the roasting phase, the darker the color of the coffee beans.

3.3 Testing by Q grader (Cupping Score)

The taste assessment scores from the treatment samples in this study which were assessed by certified panelists (Q graders) from the Gayo Cuppers Team, obtained a score of 83.50 in the F1 treatment, 85.00 in the F2 treatment, and 81.00 in the F3 treatment (Figure 5).

The treatment process in the drying phase, based on Q grader perception, is treatment F2, because treatment F2 gets 1st rank from Q grader with prominent results in aroma, flavor, body, uniformity, clean cup, sweetness and overall, while treatments F1 and F3 only stand out uniformity, clean cup, just sweetness.

Treatment F2 was roasted with a total time of 10.51, with a modification of the time in the drying phase of 4 minutes. It can be concluded that the results of these two results are that coffee is the most dominant based on the assessment of the panelists and Q graders, namely on coffee sample 2.

3.4 Sensory Assessment Through TOPSIS Method

The results of the Gayo arabica coffee sensory assessment by the identified panelists received the weight of the assessment, as shown in Table 3. The panelists filled the weight assessment of the criteria based on the level of the five preferred taste assessment attributes, with a total score of on the weight of the criteria was 100%.

After the panelists determine the weight of the criteria, decision-making based on the treatment of the coffee produced follows the stages according to the TOPSIS method. The initial stage is to form a decision matrix for sensory assessment. The decision matrix in Table 4 is built by entering the value given by the panelists to the alternatives in each treatment. After the value of the weight of the criteria in Table 3 and the sensory value in Table 4 are obtained, the results of the panelists' assessment can be built into a normalized decision matrix (Table 5).

After the normalized decision matrix is obtained from Table 5, a normalized and weighted decision matrix is compiled (Table 6) based on the calculation of the normalized decision matrix multiplied by the weight of each predetermined criterion.

The next stage is calculating the matrix of positive and negative ideal solutions (Table 7). The positive ideal solution matrix is obtained from each criterion's maximum (highest) value on the normalized and weighted decision matrix. Meanwhile, the negative ideal solution matrix is obtained from the minimum (lowest) value. The max and min values are determined from the A1-A5 values of each treatment in Table 6.

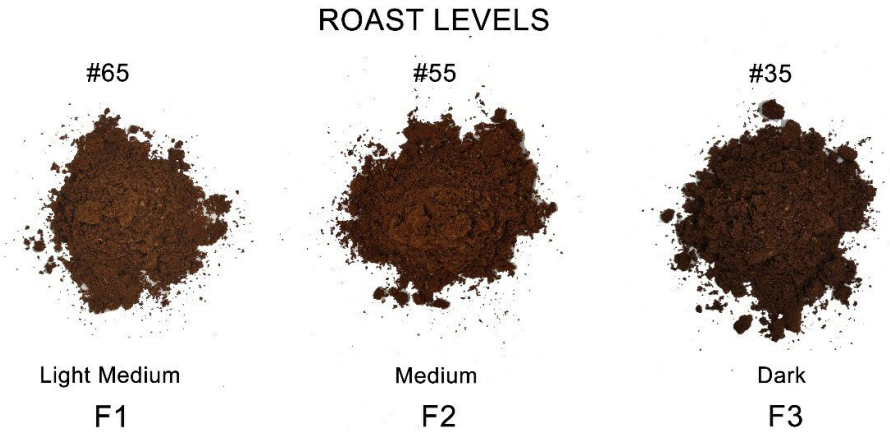
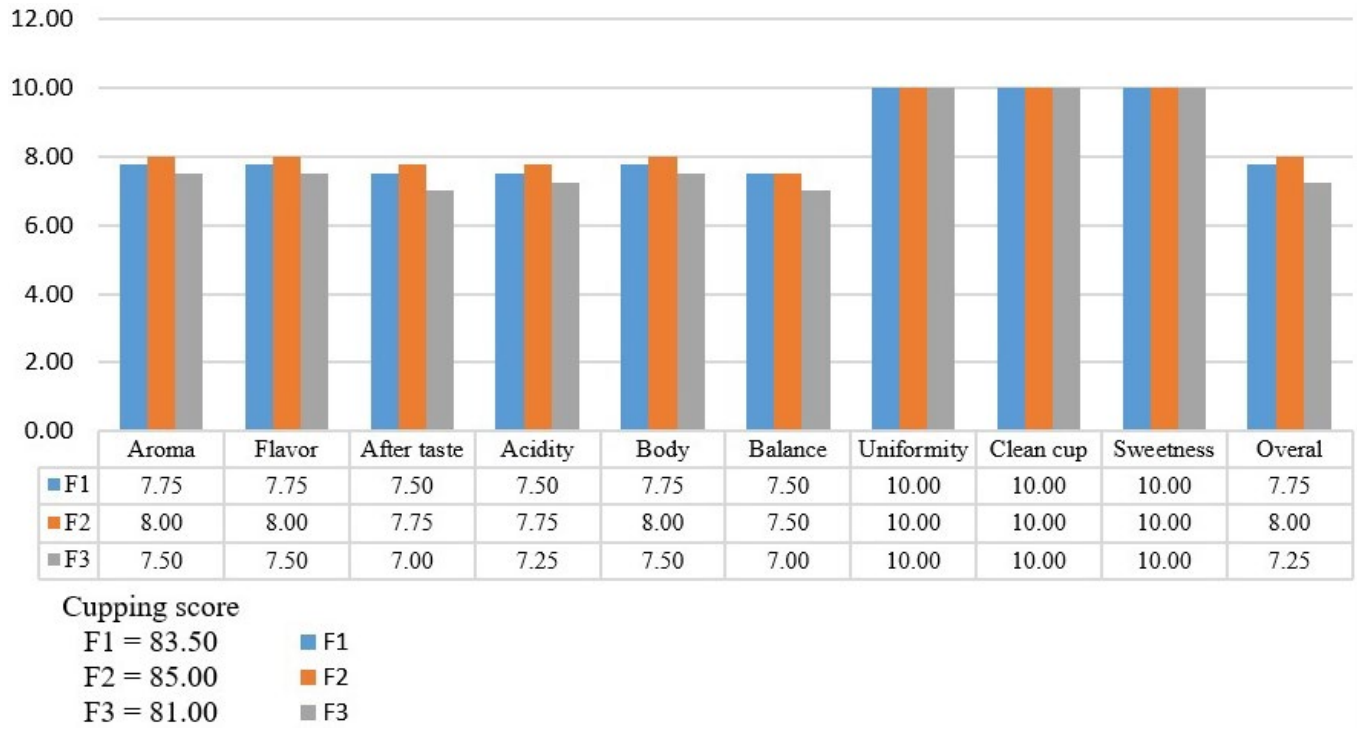


Figure 4: Roasting profile based on Agtron color scale.



	Aroma	Flavor	After taste	Acidity	Body	Balance	Uniformity	Clean cup	Sweetness	Overal
F1	7.75	7.75	7.50	7.50	7.75	7.50	10.00	10.00	10.00	7.75
F2	8.00	8.00	7.75	7.75	8.00	7.50	10.00	10.00	10.00	8.00
F3	7.50	7.50	7.00	7.25	7.50	7.00	10.00	10.00	10.00	7.25

Figure 5: Taste test results by certified panelists (Q grader).

Table 3: Criteria and weights for panelist assessment.

Criteria Code	Criteria	Weight	Description
A1	Aroma	16.7	Benefit
A2	Flavor	35.6	Benefit
A3	After Taste	16.1	Benefit
A4	Acidity	15.6	Benefit
A5	Body	16.1	Benefit
Final Weight		100%	

The next stage is determining the alternative distance with positive and negative ideal solution matrices by calculating the square root of the positive or negative ideal solution matrix from the normalized matrix with the weighted normalized matrix, as shown in Table 8.

The final stage is ranking the value of each alternative based on the largest and smallest alternative values. Then, alternative rank results are based on panelist assessments, as shown in Table 9. The final result of the TOPSIS method is the rank of treatment samples tested by the panelists. The rank obtained is taken from the highest alternative value. F2 treatment has a value of 0.88 as rank 1, then F3 treatment obtains rank 2 with a value of 0.69, and F1 treatment obtains rank 3 with a value of 0.17. From these results, it can be concluded that the F2 treatment is the coffee with the best taste compared to the other two treatments because it has the right and delicious flavor, aroma, aftertaste, acidity, and body are liked by the panelists.

Table 4: Sensory assessment decision matrix.

Alternative	Aroma (A1)	Flavor (A2)	After taste (A3)	Acidity (A4)	Body (A5)
F1 Treatment	3.44	3.22	3.56	3.67	3.22
F2 Treatment	3.89	3.89	3.67	3.89	3.56
F3 Treatment	3.89	3.78	3.44	3.33	3.78

Table 5: Normalized decision matrix.

Alternative	Aroma (A1)	Flavor (A2)	After taste (A3)	Acidity (A4)	Body (A5)
F1 Treatment	0.53	0.51	0.58	0.58	0.53
F2 Treatment	0.60	0.62	0.60	0.62	0.59
F3 Treatment	0.60	0.60	0.56	0.53	0.62

Table 6: Normalized and weighted decision matrix.

Alternative	Aroma (A1)	Flavor (A2)	After taste (A3)	Acidity (A4)	Body (A5)
F1 Treatment	8.86	18.19	9.29	9.08	8.49
F2 Treatment	10.01	21.95	9.58	9.63	9.37
F3 Treatment	10.01	21.32	9.00	8.26	9.96

Table 7: Value of positive ideal solution (Max) and negative ideal solution (Min).

Value	Aroma (A1)	Flavor (A2)	After taste (A3)	Acidity (A4)	Body (A5)
Max	10.01	21.95	9.58	9.63	9.96
Min	8.86	18.19	9.00	8.26	8.49

Table 8: S+ and S- values for each alternative.

Alternative	S+	S-
F1 Treatment	4.24	0.88
F2 Treatment	0.59	4.30
F3 Treatment	1.62	3.65

Table 9: Rank of alternatives

	Alternative		
	F1 Treatment	F2 Treatment	F3 Treatment
Value	0.17	0.88	0.69
Rank	3	1	2

4 DISCUSSIONS

The drying phase is the initial technique in the roasting process. In this phase, the color of the coffee beans changes from green to yellow. Only water content changes and a slight taste formation occurs (Copper, 2017). This drying phase occurs at the initial temperature of the coffee beans being put into the roasting machine until they end up yellowing. This phase starts from the change in temperature, the turning point at 80-90 °C, to the yellowing process at 140-160 °C. Then, it enters the maillard phase at a temperature of 170-180 °C with the appearance of the bread aroma until it ends when the first crack occurs in the coffee beans at a temperature of 190-200 °C (development phase). In the maillard phase, a pyrolytic reaction begins, causing oxidation, reduction, hydrolysis, polymerization, decarboxylation and many other chemical changes. This phenomenon is the main factor determining coffee quality's color, taste and aroma (Bottazzi et al., 2012). The development phase occurs from the first crack to the roasting machine's coffee beans (drop out). Before being removed from the roasting machine, the roaster usually determines what type of roast profile they want to achieve (light, medium or dark roast).

4.1 Roasting Graphic

The time in the drying phase of this study is appropriate to the curve graph of Cooper (2017), which is 0:00 – 5:00 minutes. It is just that the time at Cooper's (2017) turning point is around 1.20 – 1.40 minutes, therefore it is 5 seconds earlier than this study. Meanwhile, the turning point of the Cooper (2017) graph is 80-90 °C, and in this study ranges from 101-102.8 °C. The yellowing process of coffee beans on the Cooper (2017) chart and this study were in the 0:00-5:00 minutes for all treatments. The temperature in the yellowing process is also achieved appropriately to the recommended temperature of Cooper (2017), which is 140-160 °C. Only in F3 treatment exceeds the temperature limit of 173.9 °C. However, the temperature is the same as that on the Arseny Kuznetov (2019) graph, 173 °C with drying end also 5:00 minutes. Arseny Kuznetov was a roasting champion at the 2019 World Coffee Roasting Championships. These results did not significantly affect the results determined by Cooper (2017).

The maillard phase in this study, as stated in the method section, was not varied in time. It was determined through trial and error when the study was carried out by considering the curve graph of Cooper (2017). Therefore, this study's time and temperature range were not too far away, 4 minutes at a temperature of 187-209 °C, while the final maillard phase in the Cooper (2017) graph is 190-200 °C. The development phase of the Copper (2017) graph is very short, from 09:30 – 10:00, with a temperature of 209.2 °C when the first crack occurs until the coffee beans are removed from the roaster. According to Choo (2019), the development phase occurs during the first crack until the coffee beans are removed from the machine. During this time, the roasters determine the desired roast profile (level) (light, medium or dark).

The comparison results in the Cooper (2017) graph with the curve graph in this study have little difference in time and temperature. The time in the development phase is longer due to the addition of time from time variations in the drying phase. Then, the end time for each treatment is F1 treatment for 10:00 minutes, F2 treatment for 11:00 minutes, and F3 treatment for 12:00 minutes. Thus, Cooper's (2017) curve is almost similar to the curve from the results of this study.

4.2 Roasting Profile

Generally, in making an assessment based on their preference for coffee, the panelists follow what they are interested in or consume daily. Usually, the panelists who like dark coffee are appropriate to their interests. However, if there are panelists who like light and medium coffee, that coffee will get the highest score, as well as the assessment of coffee in the other two treatments. This statement can also change as the panelists feel the taste of other Arabica coffees. The assessment by the panelists also greatly influences the impact of product sales on the community. Taste assessment is generally divided according to the area where the panelists live. Jon Ferguson from Navigated (2021) stated that the preference level for coffee in the community is divided into various groups worldwide. In general, the levels are divided into eight types of criteria based on the Agtron scale classification (roast levels), namely #95 unincorporated; #85 suburbia, regiopolis; #75 urban, city; #65 city+, metropolitan, SCAA sample roast; #55 fully city, conurbation, metropolis, megacity; #45 vienna, light French, Italian, Spanish; #35 high roast, Spanish continental roast; and #25 full French, Italian roast. This is the same as the preference level for consumers. Some like light coffee, medium coffee to dark coffee, depending on their interest in taste criteria and the preference level for the roasting.

4.3 Testing by Q grader (Cupping Score)

Specialty coffee comes from the highest quality beans harvested from the world's finest Arabica coffee plants, roasted and brewed to enhance flavor potency. Q Graders evaluate the taste attributes. They have been certified by the Specialty Coffee Association (SCA) according to the protocol described in the international methodology proposed by Q Coffee Systems (Lingle; Menon, 2017).

According to the Specialty Coffee Association of America (SCAA, 2015), the specialty category in Arabica coffee is above 80 points, and the highest score scale is 100 points. Based on the SCAA statement, this study's three treatments of roasted coffee can be categorized into specialty coffee.

Coffee roasted in F1 treatment with a value of 83.50, categorized as rank 2, has seven advantages: aroma, flavor, aftertaste, acidity, body, balance, and overall. The opinion of certified panelists on F1 treatment stated that coffee has an aroma such as grassy (grass), fruity (fruits), nutty (nuts), choco (chocolate aroma), and floral (flower aroma) as well as a flavor like nutty, citrusy, short aftertaste, fruity, and hey fruity. Then, according to certified panelists, aroma and taste in F2 treatment are ranked 1 with superiority on all attributes of 10 taste assessments, with a score of 85.00 (Figure 5). According to the certified panelists from the results of the assessment, the coffee in the F2 treatment has a nutty, dark choco, fruity, tropical fruity, like cheddar, floral and herby aroma, while the taste is like choco powder, fruity, caramel, orange, floral, and slighty pear. The last is the certified panelist's assessment of the F3 treatment, categorized as taste value with the last rank in this study. It is less superior to treatments F2 and F1, with a value in treatment F3 that is 81.00. Based on the certified panelists, the aroma in this F3 treatment is dark choco, smoky and nutty, with flavors such as bitter, smoky, nutty, booring aftertaste and woody.

4.4 Sensory Assessment Through TOPSIS Method

Perceptions in the sensory assessment of coffee can be felt during the integration of complexes that stimulate a person's brain when assessing the taste of coffee (Okamoto; Dan, 2013). The multisensory taste experience is not just a combination of flavor and aroma subjectively localized to the mouth, it also involves the modulation or integration of cues that come from all the senses, including what is seen, heard, touched, and smelled (Charles et al., 2015). In addition, multisensory helps regulate the senses and hedonic (taste expected by the brain) (Charles; Betina, 2014). However, not only the food's or beverage's physicochemical properties convey information relevant to the construction of taste. Besides intrinsic product cues (e.g., color, shape, and texture of what is consumed), extrinsic cues, such as tableware and packaging, have also been shown to exert an influence on the perception of taste and hedonic assessment (Charles; Vanessa; Betina, 2012; Charles; Betina, 2014).

The panelists' assessment of the criteria weights shows that the preference level based on the sensory test of coffee gets flavor as a weight with the highest value, which is 35.6% from 100%. This happens because the flavor of coffee can be produced during the coffee bean processing, roasting and brewing. Changes in coffee flavor will undergo chemical changes, which are elements of delicious taste after processing coffee beans. The combination of flavors and steam aroma will be felt when the panelists sip the coffee. In this study, flavor gets the main rank in the selection of coffee criteria weights, which means that flavor becomes a very important priority according to the preferences of product acceptance by panelists (Navisah, 2020). This assessment is in line with several other studies, such as Sousa, Carvalho and Pereira (2020) and Jesper et al. (2020).

Generally, specialty coffee grading systems give a positive score for the presence of sweetness and "bright

sourness" and a balance between these two basic tastes while a negative score for the dominant bitterness (Togo et al., 2018). Therefore, specialty coffees are not naturally bitter but will express varying acidity and sweetness depending on several agricultural and roasting factors (Ahsan et al., 2018).

Of the three coffee treatments that have been carried out, there is a slight difference between the taste assessment by the Q grader (cupping score) as a certified panelist and the identified panelists (coffee connoisseurs and drinkers). The certified panelist's decision for F1 treatment coffee is ranked 2, but the identified panelists give a decision as rank 3. Rank 1, both from certified and identified panelists, is coffee in F2 treatment, which has the most superior taste compared to others.

These results show that the decisions of certified panelists (experts) are not always the same as those of coffee connoisseurs and drinkers (identified panelists). This can be seen in rank 2 for coffee with varying roasting time in the drying phase. Then, certified panelists had 11 assessment criteria appropriate to the SCA protocol: aroma, flavor, aftertaste, acidity, balance, sweetness, clean cup, uniformity, overall, and defects. Meanwhile, the identified panelists only had five assessment criteria, starting from aroma, flavor, aftertaste, acidity and body, resulting in different product acceptance decisions. Indeed, the interests between the two in coffee marketing practices certainly have different goals. The assessment based on the SCA protocol by certified panelists is commonly used to benefit coffee exports to foreign countries. It follows the quality standards of coffee taste for consumers abroad. Meanwhile, the panelists identified as the local community are coffee connoisseurs and drinkers in the country who may have different and expected taste sensations.

However, what is interesting from this study is that the rank 1 in the sensory quality of Gayo Arabica coffee remained the same between Q graders (certified panelists) and identified panelists. Both resulted in the decision that coffee in the F2 treatment, namely the drying phase of 4 minutes, the maillard phase of 4 minutes and the development phase of 3 minutes, was the best time for roasting this Gayo Arabica coffee. The way of the cupping test. Sniffing coffee brew while it is still hot. Cupping at the temperature of brew about 50-55 ºC. Use a spoon to get the brew to about 6-8ml, then slurp it strongly in order to stretch the brew regularly on the surface of your tongue.

5 CONCLUSIONS

This study has resulted in the decision to accept the best product from the Gayo Arabica coffee roasting in the drying phase based on cupping tests by Q Grader (certified panelists) and sensory assessments by identified panelists (coffee connoisseurs and drinkers). The taste assessment of Gayo Arabica coffee by certified panelists resulted in ranks respectively, namely treatment F2 as rank 1, treatment F1 as rank 2 and treatment F3 as rank 3. Meanwhile, according to the identified panelists, the F2 treatment was ranked 1, the F3 treatment was ranked 2, and the F1 treatment was ranked 3. The decision to accept the best product by certified and identified panelists was the same for rank 1, namely F2 treatment, but different for rank 2 and 3.

6 ACKNOWLEDGMENT

The authors would like to thank Direktorat Riset dan Pengabdian Masyarakat (DRPM) from Kementerian RISTEK DIKTI for funding this research through the "Penelitian Terapan Kompetitif Nasional (PTKN) 2022" program, No. 145/E5.PG.02.00.PT/2022.

7 AUTHORS' CONTRIBUTION

RF wrote the manuscript and performed the experiment, SS and KR supervised the experiment and co-work the manuscript, BSP review and approved the final version of the work, JF conducted all statistical analyses.

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