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Quality Characteristics of Robusta Coffee (*Coffea Canephora*) from Tebat Pulau village Rejang Lebong Regency with the Variation of Roasting Time

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ABSTRACT: Tebat Pulau Village is a formerly protected forest area that has become a community social forest processed and planted with robusta coffee. Robusta coffee from the Tebat Pulau produced by Village Farmers Group had been in great demand and attracted large buyers' attention.. However, the information on the quality profile of the coffee bean and the appropriate roasting conditions for producing the quality coffee brew is minimal. Therefore, this study was conducted to determine the quality profile of coffee beans, the physical and chemical characteristics of ground coffee, and the brewing quality of red-picked robusta coffee from Tebat Pulau village. A Completely Randomized Design with one factor, namely roasting time, was used in the study. The roasting time (P) consisted of 4 treatment levels, namely P1:10 minutes, P 2:11 minutes, P3:12 minutes, and P4:13 minutes, with a roaster temperature of 200 °C and bean temperature of 107°C. The study was carried out with three repetitions to produce 12 experimental units. The results showed that the Tebat Pulau Village Farmer Group coffee had quite large coffee beans with a water content value of 9.00%, quite a lot of (peaberry bean) coffee beans, and a total defect value of 13.83. Ground coffee samples with a long roasting time significantly affected water content, color, ash content, coffee essence, and caffeine content. The best-brewed coffee quality was obtained at 12 minutes of roasting time with a final score of 8.50, included in the "fine" category.

Keywords: coffee bean quality, evaluation of ground coffee, roasting time, robusta coffee

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INTRODUCTION

Coffee is a plantation crop that has a vital role in Indonesia's economic activities and is an export commodity that is quite important as a foreign exchange earner for the country. Apart from increasingly open export opportunities, the domestic coffee market is still quite large (Syska et al., 2022). One of Indonesia's provinces with a relatively high level of coffee production is Bengkulu Province, which will produce 63.108 tons in 2022. Bengkulu Province is also known as one of the producers of robusta coffee (*Coffea canephora*) with a land area of 92,380 ha, with *production* results of 62.080 tons in 2022, so Bengkulu has quite extensive robusta coffee plantations (Ditjenbun, 2022).

The district with the leading center for producing robusta coffee (*Coffea canephora*) is Rejang Lebong District, which contributed 18.605 tons in 2020 (Ditjenbun, 2022). The location for developing robusta coffee in Bengkulu Province is generally in the highlands of the mountains, namely between 600-1.300 meters above sea level, especially in Rejang Lebong Regency, so it has the potential to produce high-quality coffee beans (Randriani et al., 2016). Robusta coffee from Rejang Lebong, Bengkulu Province, has the distinction of being included in the top five Indonesian coffee producers known as the golden robusta triangle, apart from Lampung Province and South Sumatra Province (Listyati et al., 2017). One robust coffee-producing area in Rejang Lebong Regency is Tebat Pulau Village in Bermani Ulu District. Tebat Pulau Village is a former protected forest that has become a community social forest where robusta coffee is processed and planted. Robusta coffee in Tebat Pulau Village is managed by the Farmers Group (Poktan). The coffee products obtained from the Farmer Group are in great demand and attract the attention of large buyers. Even though coffee from the Farmer Group is widely liked and in demand, the quality profile of this coffee is not yet known, so it needs to be studied. Apart from that, information regarding the criteria for roasting coffee and the preferred quality of brewed coffee is also unknown; therefore, it is necessary to carry out roasting to find out what kind of roasting conditions are preferred using temperature and variations in the length of roasting time.

Based on the background above, this research aims to obtain the characteristics of rice coffee, the physical and chemical characteristics of ground coffee, and the organoleptic of robusta brewed coffee from the Tebat Pulau Village Farmer group at varying lengths of roasting time.

RESEARCH METHODS

Tools and Materials

The equipment used in the research includes a *roasting machine* (*Kawo Roaster*) with a capacity of 5 kg, *a* grinder machine (*Nankai*), 60 *mesh sieve,* analytical balance, an oven, a *desiccator*, crucible tongs, an aluminum cup, a baking pan, *spectophotometry* (*Genesys 10S UV-Vis*), cuvette, separating funnel, distillation equipment, *hot plate*, Erlenmeyer, measuring cup, beaker, measuring flask, dropper pipette, *aluminum foil*, water bath, filter paper, funnel, porcelain cup, spoon, basin, *standing pouch*, tray, *tissue*, *Munsell Color Chart for Plant Tissues* application, and camera. The main ingredient used in this research was Robusta *Ciary rice coffee beans* from the Tebat Pulau Village Farmers Group, Bermani Ulu District, Rejang Lebong Regency. Research-supporting materials are anhydrous caffeine, chloroform, distilled water, and calcium carbonate ($CaCO_3$).

Research Design

The experimental design used was a Completely Randomized Design (CRD) with a single factor. The factor tested was a roasting time (P) with four treatment levels: P_1: 10 minutes, P_2: 11 minutes, P_3: 12 minutes, P_4: 13 minutes with a *roaster temperature* of 200°C and a *bean temperature* of 107°C. Each treatment consisted of 3 repetitions to obtain 12 experimental units.

Preparation of Raw Materials for Rice Coffee

The sample used in this research was *Ciary robusta coffee beans* originating from the Tebat Pulau Village Farmers Group, Bermani Ulu District, Rejang Lebong Regency. The sample was red-picked coffee fruit with a dry processing process. In this case, the researcher only bought samples of *green beans* ready for *roasting*. The amount of *green bean* coffee used was 24 kg.

Roasting

Roasting is a process of roasting coffee beans that depends on time and temperature and is characterized by significant chemical changes. Roasting rice coffee beans was carried out using a *roasting machine* (*Kawo Roaster*) with a capacity of 5 kg. In this case, the researchers only used 2 kg of coffee in one roasting session. Coffee beans begin to be roasted when the *roaster temperature* reaches 200°C with four variations of roasting time, namely 10 minutes, 11 minutes, 12 minutes, and 13 minutes, done three times.

Milling

After roasting, the roasted coffee beans are followed by a *resting process* for one day. Resting is the time for coffee beans after roasting before being processed into coffee powder. *The roasted* coffee beans that are still hot need to be *rested* to avoid excessive heating and release the coffee's distinctive aroma. During the *resting process*, the coffee beans are placed in a plastic container (Prasetyo, 2022). After resting, the roasted coffee beans are ground using a coffee *grinder* (*Nankai*) machine. The *grinding* process is an advanced stage that aims to refine (reduce the size of the coffee beans). This reduction is to make the coffee brewing process more accessible. Next, filtering is carried out using a 60-mesh *sieve* to uniform the size of the coffee grains (60 *mesh grain size*).

Physical Characteristics and Quality of Robusta Coffee Beans

Rice Coffee Defect Value

300 g of rice coffee from 2 kg of coffee is weighed and then selected and separated from defective beans and impurities in the coffee samples that have been weighed. Then, the samples were placed separately in each *cup*. Next, the defect value is calculated by adding up the types of coffee defects with the defect value according to *the form* for determining the number of defects (BSN, 2008).

Rice Coffee Water Content

Rice coffee beans were weighed as much as 2 g with three repetitions. The sample was placed in an aluminium cup and then in the oven at 105°C for 2 hours. After being in the oven, the sample was cooled in a desiccator until it reached room temperature. Next, the sample is weighed again. Water content is calculated using the formula in SNI 01-3542-2004 (BSN, 2004) :

$$Water\ content = \frac{w_0 - w_1}{w_0} \times 100\% \qquad (1)$$

Information:
w_0 = initial weight (g)
w_1 = final weight (g)

Coffee Passes Through Sifter

A 200 g of rice coffee comes from a 2 kg sample in a container previously weighed and sifted using a round hole sieve with a diameter of 6.5 mm and 3.5 mm. Then weigh the sample that passes with an accuracy of 0.01 g, then express it in % mass fraction (BSN, 2008):

$$\text{Pass-screnned bean} = \frac{\text{Weight of pass-screnned bean (g)}}{\text{Weight of bean ample (g)}} \times 100\% \qquad (2)$$

Number of Seeds Per 500 g

Classification of beans based on the number of robusta coffee beans per 500 g. The test sample weighed 500 g of Robusta coffee beans, and then the number of beans contained in 500 g was calculated (Widyotomo and Yusianto, 2013).

Peaberry Coffee

The number of Peaberry rice coffee beans (%) was calculated based on the total weight of peaberry coffee beans per 500 g coffee bean sample.

Physical Characteristics of Robusta Ground Coffee

Water content

Ten g of ground coffee was weighed with three repetitions at each *roasting level*, so 12 samples were obtained. The sample was placed in an aluminum cup and then in an oven at 105 °C for 2 hours. After being in the oven, the samples were cooled in a desiccator until they reached room temperature. Next, the sample is weighed again. Water content is calculated using the formula (BSN, 2004) :

$$Water\ content = \frac{w_0 - w_1}{w_0} \times 100\% \qquad (3)$$

Information:
w_0 = initial weight (g)
w_1 = final weight (g)

Color (brightness)

Color testing uses *the Munsell color charts for plant tissues*, namely by comparing the color of the sample with the *Munsell color charts for plant tissues*. The numbers listed on *the Munsell color charts for plant tissues* are a color spectrum of three variables, namely: (1) *hue*, (2) *value*, and (3) *chroma*. *Hue* is a spectrum color (red, green, or yellow) with a wavelength of. *Value* shows how dark a color is according to the amount of light reflected. *Chroma* is defined as a gradation of purity from the degree of differentiation of changes in color intensity (Priandana et al., 2016).

Chemical Characteristics of Robusta Ground Coffee

Ash Content

A 3 g of ground coffee was weighed, and the sample was put into a porcelain cup with measured weight. The sample was aerated over a burner flame and then ashed in an electric furnace at a maximum temperature of 550°C. The sample was cooled in a desiccator and weighed until the weight remained constant. Then, the ash content can be calculated using the formula in SNI 01-3542-2004 (BSN, 2004):

$$Ash\ content = \frac{w_1 - w_2}{w}\ 100\% \quad \textbf{(4)}$$

Information:
w: sample weight before ashing (g)
w_1: sample weight + cup after ashing (g)
w_2: weight of empty cup (g)

Caffeine Content

The ground coffee sample was weighed as much as 2 g. Then, the sample was put into a 500 mL beaker. Next, 200 mL of boiling water was added to the beaker and left for 1 hour. The sample solution was filtered using filter paper and a funnel into a 500 mL Erlenmeyer flask, then rinsed with hot water until the solution that dripped out of the funnel was clear. After that, the sample solution was allowed to reach room temperature. Then, water is added to the solution and adjusted to the line mark on a 500 mL *Erlenmeyer flask*. Then, take 50 mL of the sample solution into a porcelain cup of known weight, heat the solution in a water bath until dry, then put it in the oven at 105°C for 2 hours. The sample is cooled in a desiccator and weighed until the weight is stable. Then, the juice content can be calculated using the formula in SNI 01-3542-2004 (BSN, 2004).

$$coffee\ extract = \frac{w_1\ x\ 500}{w_2\ x\ 50}\ 100\% \quad \textbf{(5)}$$

Information:
w_1: extract weight
w_2: sample weight

Caffeine Levels

1) Preparation of standard solution standard

Standard caffeine is weighed as 20 mg and put into a 100 mL volumetric flask. Then, the caffeine standard was dissolved in distilled water until the mark on the volumetric flask and shaken until homogeneous to obtain a stock solution with a concentration of 200 ppm.

2) Determination of the absorption wavelength maximum

A 10 mL of the mother solution was put into a 100 mL measuring flask. Then, the stock solution was dissolved with distilled water until the limit mark on the volumetric flask to obtain a standard solution with a concentration of 20 ppm. The absorbance of the standard solution was measured *spectrophotometrically* with a maximum wavelength of 276 nm.

3) Determination of the calibration curve

A calibration curve is obtained by preparing a series of standard solutions with concentrations 0, 20, 40, 60, 80 And 100 ppm, with the method pipetting each amount of 0, 10, 20, 30, 40 and 50 mL into a 100 mL measuring flask, then dissolve with distilled water until the mark. Each standard solution was put into a different cuvette, while the other cuvette was only filled with distilled water as a blank (comparison with the standard solution). After that, the cuvette containing each solution was put into *spectrophotometry,* and the absorbance was measured at a wavelength of 276 nm.

4) Sample preparation

A 2 g sample of ground coffee was put into an Erlenmeyer flask and dissolved in 100 mL of boiling distilled water. The coffee solution was filtered until it was separated from the dregs, and then 1.5 g of $CaCO_3$ was added to the filtrate solution and heated again. After the solution has cooled, put it into a separating funnel. Then, the filtrate solution was extracted with 25 mL chloroform to separate the caffeine content and the coffee solution. The chloroform solvent will bind the caffeine to the bottom of the funnel, and then the filtrate (a clear yellow solution) is collected into an Erlenmeyer flask. Washing using chloroform was repeated four times in a row to obtain the caffeine content to the maximum. Then, the chloroform solvent is evaporated using a distillation apparatus to separate the chloroform from caffeine to obtain caffeine extract in crystal form. The resulting caffeine extract is dissolved in distilled water and put into a 100 mL volumetric flask until the limit mark. After that, the dilution was done by pipetting 2 mL of the caffeine solution into a 50 ml measuring flask and dissolving with distilled water until the mark.

5) Determination of caffeine levels

The absorption of 12 caffeine extract samples was measured for absorption at the maximum absorption wavelength obtained, namely 276 nm, by being put into different cuvettes. In contrast, one other cuvette was only filled with distilled water as a blank (comparison with the sample solution). After that, the cuvette containing each solution was put into spectrophotometry, *and* the absorbance was measured, then the absorbance was recorded. The caffeine concentration will be determined based on the regression equation, namely $y = a + bx$, from the standard calibration curve (Suwiyarsa et al., 2018).

Organoleptic Test (Hedonic/liking Test)

testing is carried out using the *cupping test* method by one trained panellist certified by *Coffee Cupping International,* which refers to SCCA (*Specialty Coffee Association of America*). The attributes tested include *fragrance, flavour, aftertaste, acidity, sweetness, mouthfeel, balance, uniformity, clean cups, and overall*. This test is carried out to assess the taste of coffee (SCAA, 2015). *In preparation of ground coffee samples, the ground coffee used was a type of roasted coffee from Tebat Pulau Village* with four levels of treatment. In the first stage, the researchers prepared a sample of 8.25 g of Robusta coffee, which had been roasted, *ground* and sieved with 60 *mesh*. Next, 120 mL of the coffee sample was brewed using hot water at a temperature of 85°C. Then, the panellists assessed (*cupping test*) on sry-ground and brewed coffee. Samples *The* sensory assessment score (*cupping test)* in the form of numbers representing the level of coffee quality on a numerical scale of 6-9 can be seen in Table 1.

Table 1. Score Cupping Test Robusta

Quality Scale	Score
Good	6.00 - 6.75
Very Good	7.00 - 7.75
Fine	8.00 - 8.75
Outstanding	9.00 - 9.75

Source: SCAA, 2015

Data analysis

The data obtained were analyzed using the ANOVA test. If the data shows a real influence, it is continued with the DMRT *(Duncan's Multiple Range Test) test* with a significance level of 5% using the SPSS 26.0 program. Meanwhile, the data obtained from the organoleptic test will be analyzed using the *Cupping test*.

RESULTS AND DISCUSSION

Physical Characteristics and Quality of Coffee Beans

The physical characteristics of rice coffee include water content, coffee that passes through the sieve, Peaberry coffee, and the number of coffee beans per 500 g. The results of tests on the physical characteristics of rice coffee beans in this study can be seen in Table 2.

Table 2. Physical Test Results for the Quality of Robusta Rice Coffee

Quality Parameters	Average Results Measurement (%)	Quality Requirements (SNI 01-2907-2008)
Moisture Content of Coffee Beans	9.00 ± 0.043	Maximum 12.5%
Coffee Passes a 6.5 mm Sifter	4.98 ± 0.002	Maximum pass 5%
Coffee Passes a 3.5 mm Sifter	0	
Peaberry Coffee Beans (*Peaberry Beans*)	17.46 ± 0.037	
Number of Seeds Per 500 g*	1929 ± 3	

Type : *= Number of seeds

Defect and Quality Value

The defect value found in coffee beans is one of the characteristics that will affect the quality of the coffee produced. The defect value also greatly determines the quality of the rice coffee; the higher the defect value produced, the lower the quality of the coffee (Abubakar et al., 2022). The value of defects in coffee beans can be reduced by carrying out a sorting process based on physical defects following SNI 01-2907-2008. The value of defects in rice coffee beans in this study can be seen in Table 3.

Table 3. Number and value of defects in coffee beans rice robusta Farmer Group in Tebat Pulau Village

Type of Defect	Defect Value (SNI 01-2907-2008)	Robusta Ciary Tebat Pulau	
		Number of Defects	Total Defect Value
Black Seed	1.00	3.67	3.67
Partial Black Seeds	0.50	3.33	1.67
Cacao bean	0.25	2.00	0.50
Medium Size Coffee Bark	0.50	4.67	2.33
Small Size Coffee Bark	0.20	8.00	1.60
Broken Seeds	0.20	9.33	1.87
Young Seeds	0.20	3.33	0.67
Hollow Seeds 1	0.10	7.33	0.73
Seeds with more than one hole	0.20	4.00	0.80
Total		45.67	13.83*
Quality/ *Grade*			Quality 2

Note: *= Quality 1 Maximum Number of Defect Values 11
Quality 2 Number of Defect Values 12-25*
Quality 3 Number of Defect Values 26-44
Quality 4_a Number of Defect Values 45-60
Quality 4_b Number of Defect Values 61-80
Quality 5 Number of Defect Values 81-150
Quality 6 Number of Defect Values 151-225

Table 3 shows the defects and the defect values found in Robusta green coffee beans of the Farmer Group in Tebat Pulau Village, Rejang Lebong Regency. The total number of defects obtained was 45.67, while the total number of defects obtained was 13.83. Based on the coffee bean quality standard (SNI 01-2907-2008), the total number of defect values obtained in this study meets the quality requirements for coffee beans, which are included in the quality requirement category 2 with the requirement for the number of defect values to be 12-25 (National Standardization Agency, 2008). Harvesting red picks produces better-quality coffee beans (Hidayat et al., 2021).

Defect value was analyzed based on the provisions in SNI-01-2907-2008 regarding coffee beans. The defect values analyzed comprised 20 criteria for types of defects in coffee beans. Still, in this study, only nine criteria were found for defects in coffee beans: black beans, partially black beans, brown beans, medium-medium-sized coffee skins, small-sized coffee skins, and broken beans. , young beans, seeds with one hole and seeds with more than one hole. The highest percentage of defective types of Robusta rice coffee beans from Tebat Pulau Village Farmers Group is found in black beans with a value of 3.67 and medium-sized coffee skins with a value of 2.33, followed by broken beans, partial black beans and small coffee skins.

Black bean defects are generally caused by diseases that attack coffee, while black beans will affect total acidity (Setyani et al., 2018). Black bean defects and young beans come from young coffee cherries. The percentage of defects in young beans is estimated to occur due to the inclusion of young coffee berries in the picking process or imperfect sorting of red fruit. Hollow bean defects are caused by insect attacks, namely the coffee berry borer (*Hypothenemus hampei Ferr.*) (Novita et al., 2010). The types of defects that can occur due to the processing process are broken beans, brown beans, spotted beans, horn-covered beans and coffee logs, but the types of defects that result from the processing process in this study are only broken beans and brown beans. Broken beans occur while stripping the skin of the coffee fruit (*pulping*). Chocolate beans usually occur due to improper drying, overripe fruit or excessive fermentation (Winarno & Angin-Angin, 2020).

Moisture Content of Rice Coffee

Water is one of the important components in a food product whose presence influences the appearance, texture, and taste of food and determines the acceptability, freshness and durability of food ingredients in the storage process (Saloko et al., *2019*). Water content is the percentage of water content of a material, which can be expressed based on wet or dry weight. The shelf life of a food can be extended by removing some of the water in the food until it reaches a certain water content (Saleh et al., 2020).

In this study, the water content value of Robusta rice coffee for the Farmer Group in Tebat Pulau Village was 9.00% (Table 4). Based on coffee bean quality standards (SNI 01-2907-2008), the results of water content testing have met the coffee bean quality requirements, with a maximum permitted water content value of 12.5% (Badan Standardisasi Nasional, 2004). From the results of testing the robusta rice coffee's water content, the Tebat Pulau Village farmer group is of good quality with a water content of less than 12.5%, which is by coffee bean quality standards. The lower the water content in coffee beans, the less likely the material will be contaminated by microorganisms in storage (Wiranata, 2016).

Coffee Passes Through Sifter

Coffee passing through a sieve is a stage of separating rice coffee based on large, medium and small sieve sizes (Badan Standardisasi Nasional, 2017). The coffee passes through the sieve to determine the size of the rice coffee beans based on coffee bean quality standards (SNI 01-2907-2008). Based on the quality requirements for dry processing Robusta coffee beans, the sieve size used is a 6.5 mm diameter sieve (*Sieve* no. 16) for large-sized coffee and a 3.5 mm diameter sieve (*Sieve* no. 9) for small-sized coffee.

The results of testing for coffee passing through the sieve for Robusta coffee from the Farmer Group in Tebat Pulau Village showed that there were differences in the value of coffee passing through the sieve for the two uses of different sieves with dry processing based on the provisions of coffee bean quality standards (SNI 01-2907-2008). On a sieve with a diameter of 3.5 mm (*Sieve* no. 9), no coffee beans passed through the sieve or a value of 0% (Table 10). Meanwhile, for a 6.5 mm diameter sieve (*Sieve* no. 16), the coffee beans passed the sieve with a value of 4.98% (Table 4). Based on coffee bean quality standards (SNI 01-2907-2008), the test results for coffee passing through the sieve for dry processed Robusta coffee in this study have met the coffee bean quality requirements, with a maximum pass requirement of 5% (National Standardization Agency, 2004). Coffee beans that pass through a 6.5 mm diameter sieve with the criteria for large coffee consist of broken beans and young beans/small beans, but these coffee beans do not pass through a 3.5 mm diameter sieve with the criteria for small coffee. According to, the size of coffee beans is important in determining the quality of coffee beans and greatly influences the selling price. Bean size uniformity is a general quality criterion consumers consider when purchasing coffee beans (Aklimawati et al., 2014).

Number of Seeds Per 500 grams

The number of beans per 500 g results from calculating the total number of beans in a sample of Robusta coffee beans previously weighed at 500 g. The results of testing the number of seeds per 500 g of Robusta rice coffee from the Farmer Group in Tebat Pulau Village in this study were 1,929 seeds (Table 4). It aligns with research by Budiyanto et al. (2021) that the number of coffee beans obtained in this study was not much different from the number of coffee beans obtained from the Kirmanan clone robusta coffee, 1,927 beans.

Peaberry Coffee Beans

Peaberry coffee has whole, round, raw beans or one-seeded fruit. Peaberry coffee beans have an oval-round shape and are small in size, unlike regular coffee beans (Suhandy et al., 2018). Peaberry coffee production is minimal, only around 2-5% of the total coffee fruit production (Aditya et al., 2016). The results of testing Peaberry coffee beans on robusta coffee from the Farmer Group in Tebat Pulau Village in this study were 17.46% (Table 4). These results align with research by Anggari (2018) that Peaberry coffee is more commonly found in coffee plantations in the highlands (above 1000 masl). In this case, the Tebat Pulau Village Farmers Group's Robusta coffee grows 1000 meters above sea level.

Physical Characteristics of Ground Coffee

Water content

Water content is one of the physical properties that will influence the quality of coffee, related to shelf life to prevent color changes, mould growth, and other microorganisms. (Novita et al., 2010). The lower the water content of a product, the longer the shelf life of a material; conversely, if the dry material is not too dry, it will have a lower shelf life (Agustina et al., 2019). The results of water content testing on ground robusta coffee from the Tebat Pulau Village Farmers Group based on variations in roasting time can be seen in Figure 1.

The results of the ANOVA test show that the length of roasting time significantly affects the water content of Robusta ground coffee with a significance level of 0.00<0.05. Further DMRT (Ducan Multiple Range Test) tests at the 5% level (α=0.05) showed that the 10-minute roasting treatment significantly differed from the 11-minute, 12-minute and 13-minute treatments. The 11-minute roasting length treatment differed significantly from the 10- and 13-minute treatments but not significantly from the 12-minute treatment. The 12-minute roasting length treatment differed significantly from the 10-minute but not significantly from the 11- and 13-minute treatments. The 13-minute treatment was significantly different from the 10-minute and 11-minute treatment but not significantly different from the 12-minute treatment.

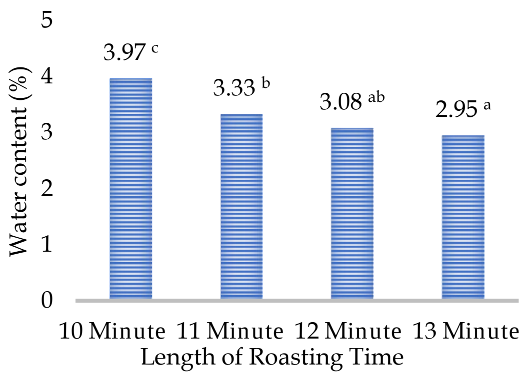


Figure 1. Water Content of Coffee Powder Robusta Tebat Island Village Farmer Group with Variations in Length of Roasting Time.

Figure 1 shows that the water content value of ground coffee obtained varies for each treatment based on the length of roasting time. The water content of ground coffee is in the range of 2.95% - 3.97%. Based on Indonesian standard (SNI 01-3542-2004) of ground coffee, the water content test results obtained in this study have met the quality requirements for ground coffee, with a maximum permitted water content value of 7% for quality requirements category I and quality II. (BSN, 2004). The lower the water content, the

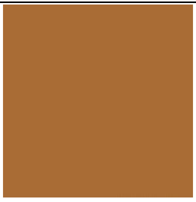
The results of this research are in line with several other studies, which state that the longer the roasting time, the lower the water content in ground coffee (Ilham et al. (2021) ;Saloko et al. (2019); Tyas (2019). The roasting temperature of 220° C resulted roasted coffee with a water content of 2.41% in 8 minutes. Marpaung and Lutvia (2020) reported that the longer the roasting time, the more water evaporates from the coffee beans. During the roasting process, heat transfer occurs from the roasting medium to the coffee beans, which changes the mass of water from the coffee beans into water vapour. The expected water content in a product resulting from a treatment is the lowest. The lower the water content, less likely the material will be contaminated by microorganisms in storage and maintain the resistance of the material from damage by microorganisms during storage (Purnamayanti et al., (2017); Wiranata, (2016).

Color

Color is important in coffee commodities, such as an attraction, identification mark and sensory attribute. Color is a quality factor that attracts consumers' attention and most quickly gives an impression of liking or disliking (Fauzi et al., 2019).

Color testing of roasted ground coffee was carried out using *the M unsell color chart for plant tissue* application. Color testing uses *the M unsell colour chart for plant tissues* expressed with notations (symbols) that can be translated into quantitative language. The *hue* value represents the dominant wavelength that will determine whether the color is red, green, or yellow. The value *shows* the darkness of the color. The smaller the number, the darker the color, while *chroma* shows the intensity of the color, the higher the number, the brighter the color. The results of testing the color of ground coffee using *the Munsell color chart for plant tissues* can be seen in Table 4.

Table 4. Color Results Using Munsell Color Charts For Plant Tissues.

Length of Roasting Time	*Munsell Color Charts*	Treatment Ground Coffee Color	Information
P1 (10 Minutes)			7.5 YR (a) 5 (b) /6 (c)
P2 (11 Minutes)			7.5 YR (a) 4 (b) /6 (c)
P3 (12 Minutes)			7.5 YR (a) 3 (b) /4 (c)
P4 (13 Minutes)			7.5 YR (a) 2 (b) /4 (c)

Note: a = *Hue*. b = *Value*, c = *Chroma*

Table 4 shows that coffee powder changes color with the length of roasting time. In the 10-minute roasting treatment, the color was 7.5 YR 5/6, the roasting time was 11 minutes, the color was 7.5 YR 4/6, the roasting time was 12 minutes, the color was 7.5 YR 3/4 and the roasting time was 13 minutes, the color was obtained. 7.5YR 2/4. The longer the roasting time used, the darker the color of the coffee grounds will be. The brightest coffee powder color was obtained in the 10-minute roasting treatment, 7.5 YR 5/6, while the darkest coffee powder color was obtained in the 13 13-minute roasting treatment, 7.5 YR 2/4. It shows that the brightness of each treatment is significantly different from each other. The color test results showed that all treatments experienced changes in *value* and *chroma values*, with the results getting smaller as the treatment increased in length of roasting time. The smaller the *value* and *chroma values* obtained, the darker the color of the resulting coffee powder will be. It is in line with Wiranata (2016) that the longer the roasting process causes the brightness level of the coffee grounds to become smaller or the color darker.

The coffee powder color results obtained in Table 6 show the color from light brown to dark brown as the roasting time increases. It is in line with the research Setyani et al. (2018) that the roasting process of coffee beans affects the color of the coffee produced. The longer the roasting process, the more coffee beans. The resulting product will be blackish brown. The color of coffee beans changes to blackish brown because the Maillard reaction occurs during the roasting process. The *Maillard* reaction is a condensation reaction of amino acids and proteins in the presence of glucose (Hayati et al., 2012). It is also following Hutahaean et al. (2021) that the length of roasting time affects the color level of coffee beans; the longer the roasting time, the blacker the coffee beans are produced due to the *Maillard reaction,* which forms volatile compounds, caramelization and the formation of CO_2 as a result of oxidation, during roasting. Marpaung & Lutvia (2020) also stated that the longer the roasting time, the more the color produced will lead to the roasting level, characterized by the color of the coffee beans becoming blacker.

Chemical Characteristics of Ground Coffee

Ash Content

Ash content is the number of minerals found in food, whereas the minerals found in coffee are potassium, calcium, magnesium, and non-metallic minerals, namely phosphorus and sulphur (Oktadina et al., *2013*). The high ash content is due to the high mineral content; apart from that, dirt and the remaining epidermis can also affect the ash content contained in coffee beans (Ciptaningsih, 2012). The results of testing the ash content of UK Robusta ground coffee based on variations in roasting time can be seen in Figure 2.

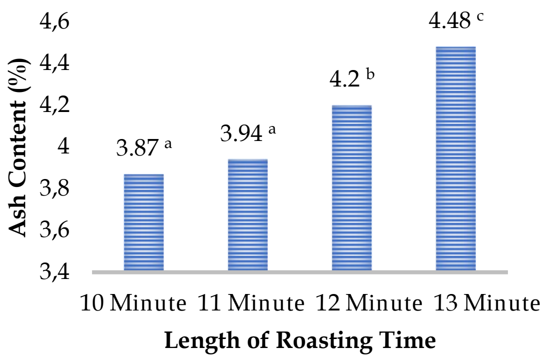


Figure 2. Ash Content of robusta ground coffee farmers group in Tebat Island Village with variations in roasting time.

ANOVA test results show that the length of roasting time significantly affects the ash content of Robusta ground coffee with a significance level of 0.001<0.05. The results of the DMRT (*Ducan Multiple Range Test)* further test at the 5% level (α = 0.05) showed that the 10-minute roasting treatment was significantly different from the 12- and 13-minute treatments but not significantly different from the 11-minute treatment. The 11-minute roasting length treatment differed significantly from the 12- and 13-minute treatments but not significantly from the 10-minute treatment. The 12-minute roasting treatment significantly differed from the 10-minute, 11, and 13-minute roasting treatment. The 13-minute roasting treatment significantly differed from the 10-minute, 11-minute and 12-minute treatments.

Picture 2 shows that The k value of ground coffee ash content obtained varies for each treatment based on the length of roasting time. The ash content value of ground coffee is in the range of 3.87% - 4.48%. The highest ash content was obtained in the 13-minute roasting treatment at 4.48%, while the lowest was obtained in the 10-minute roasting treatment at 3.87%. Based on the quality standard for ground coffee (SNI 01-3542-2004), the ash content test results obtained have met the quality requirements for ground coffee, with a maximum permitted ash content value of 5% for quality requirements category I and quality II (Badan Standardisasi Nasional, 2004).

The results of this study show that the ash content values obtained in each treatment with long roasting time indicate an increase in ash content. The longer the roasting time, the more the ash content in ground coffee will increase. It aligns with research by Ilham et al. (2021) that the longer the roasting, the higher the ash content value of the roasted coffee beans. The increase in ash content is due to the longer the roasting, the water content of the roasted coffee beans will decrease so that the percentage of ash content increases. The high ash content indicates the high mineral components in the coffee beans. Saloko et al. (2019) also stated that the longer the roasting, the higher the ash content contained in robusta coffee. The increase in ash content is caused by temperature treatment and long roasting, which causes a decrease in water content and other compounds, such as antioxidants. It is also following Hutahaean et al. (2021) that the ash content of roasted coffee beans increases with the length of roasting. The increasing ash content is associated with decreasing water content. The high ash content in ground coffee from roasting shows the high mineral content in ground coffee.

Coffee Essence Content

Results of testing coffee essence content in ground robusta coffee from the Tebat Pulau Village Farmers Group based on variations in long roasting time can be seen in Figure 3. The results of the ANOVA test show that the level of robusta ground coffee essence significantly affects the length of roasting time with a significance level of 0.000<0.05. It follows Edowai (2019) that coffee essence is related to its solubility and the factors that influence solubility, namely temperature, time and surface area. Further DMRT (*Ducan Multiple Range Test)* tests at the 5% level (α = 0.05) showed that the 10-minute roasting treatment significantly differed from the 11-minute, 12-minute and 13-minute treatments. The 11-minute roasting treatment significantly differed from the 10-minute, 12, and 13-minute roasting treatments. The 12-minute roasting length treatment differed significantly from the 10- and 11-minute treatments but not significantly different from the 13-minute treatment. The 13-minute roasting length treatment differed significantly from the 10- and 11-minute treatments but not significantly from the 12-minute treatment.

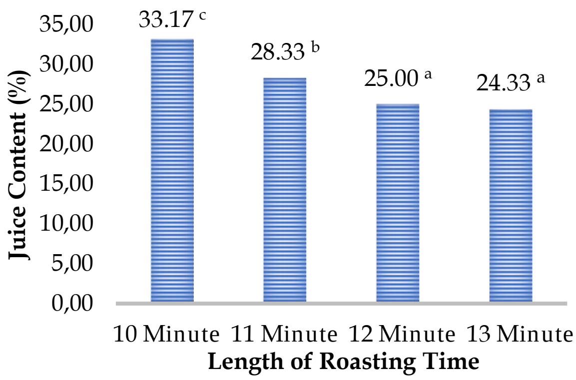


Figure 3. Coffee Extract Contents Robusta Powder Farmers Group Tebat Island Village with Variations in Length of Roasting Time.

The essence of coffee brewing content is a substance dissolved in water during brewing (Edowai, 2019). The content of coffee essence is related to the solubility of the material itself; that is, the higher the level of coffee essence, the higher the solubility of the material in water (Suwarnimi et al., 2017). Figure 3 shows that the value of the ground coffee essence obtained varies for each treatment based on the length of roasting time. The value of ground coffee essence is in the range of 24.33% - 33.17%. The highest coffee essence content was obtained in the 10-minute roasting treatment at 33.17%, while the lowest coffee essence content was obtained in the 13-minute roasting treatment at 24.33%. Based on the ground coffee quality standard (SNI 01-3542-2004), the coffee extract test results obtained have met the quality requirements for ground coffee , with the permitted coffee extract value being a maximum of 20-36% for category I quality requirements and a maximum 60% category II quality requirements (National Standardization Agency, 2004) .

The results of this study show that the value of coffee juice obtained in each treatment with long roasting time shows a decrease in coffee juice. The longer the roasting time, the more the juice content in ground coffee will decrease (Budiyanto et al., 2021; Edvan et al., 2016). According to Fibrianto & Ramanda (2018), coffee juice is greatly influenced by the particle size and surface area of the particles in contact with the solvent. The more dissolved coffee means less grounds and a larger surface area of ground coffee.

Caffeine Levels

Caffeine is a type of alkaloid. It is naturally found in many coffee beans, tea leaves and chocolate seeds that are crystalline and taste bitter (Suwarnimi et al., 2017). The results of testing caffeine levels in ground robusta coffee based on variations in roasting time can be seen in Figure 4.

ANOVA test results show that robusta ground coffee's caffeine content significantly affects the length of roasting time. The results of further DMRT (*Ducan Multiple Range Test)* tests at the 5% level (α = 0.05) showed that the roasting treatments of 10 minutes, 11 minutes, 12 minutes and 13 minutes were significantly different from all treatments.

Figure 4 shows that the highest coffee caffeine content was obtained in the 10-minute roasting treatment at 2.11%, while the lowest coffee caffeine content was obtained in the 13-minute roasting treatment at 1.42%. Based on the quality standard for ground coffee (SNI 01-3542-2004), the results of testing the caffeine content of coffee obtained from all treatments have met the quality requirements for ground coffee, with permitted coffee caffeine content values, under quality requirements category II (Badan Standardisasi Nasional, 2004). Meanwhile, the 10-minute roasting treatment did not meet the quality standards for ground coffee (SNI 01-3542-2004) because it had a caffeine content higher than the requirements for quality I and II.

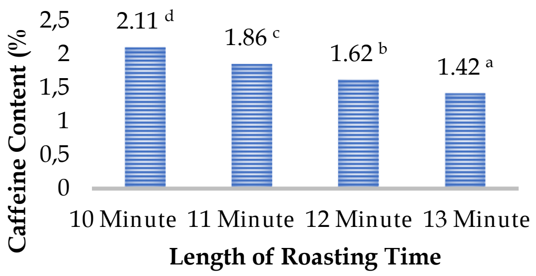


Figure 4. Caffeine Content Robusta Coffee with Variations in Length of Roasting Time.

The results of this study show that the values obtained for each treatment with long roasting time indicate a decrease in coffee caffeine levels. The longer the roasting time, the higher the caffeine content in ground coffee because the roasting process can burn the caffeine, so the longer the coffee is roasted, the caffeine content in ground coffee will decrease. Tyas (2019) also stated that the length of roasting time resulted in a percentage of. The same thing as Budiyanto et al. (2021) is that coffee's caffeine content decreases with increasing roasting levels. It is also following Heriana et al. (2023) that the caffeine content will increase using low temperatures and fast times, while the longer and higher the roasting temperature, the caffeine content will decrease. Due to the higher temperature and roasting time, it is estimated that most of the caffeine will sublimate into caffeine, so the amount in coffee grounds will decrease. The decrease in caffeine levels occurs because there is a sublimation process to form other components (Tfouni et al., 2013).

Organoleptic of Brewed Coffee (*Cupping test*)

One trained panellist performed sensory testing using the cupping test method in this study. The coffee *cupping* method is one of the methods used to assess the taste of coffee because each type of coffee has different taste characteristics, so this coffee *cupping* is considered good enough to differentiate the characteristics of coffee. The *cupping test* method will obtain quality coffee taste from the varieties undergoing sensory evaluation (Yulia, 2018).

This cupping test was carried out following the 2015 SCCA (Specialty Coffee Association of America) procedures. *The results of the flavour attribute score assessment and the results of* the flavour character assessment in the *cupping test* of Robusta ground coffee with variations in roasting time can be seen in Figure 5 and Table 7.

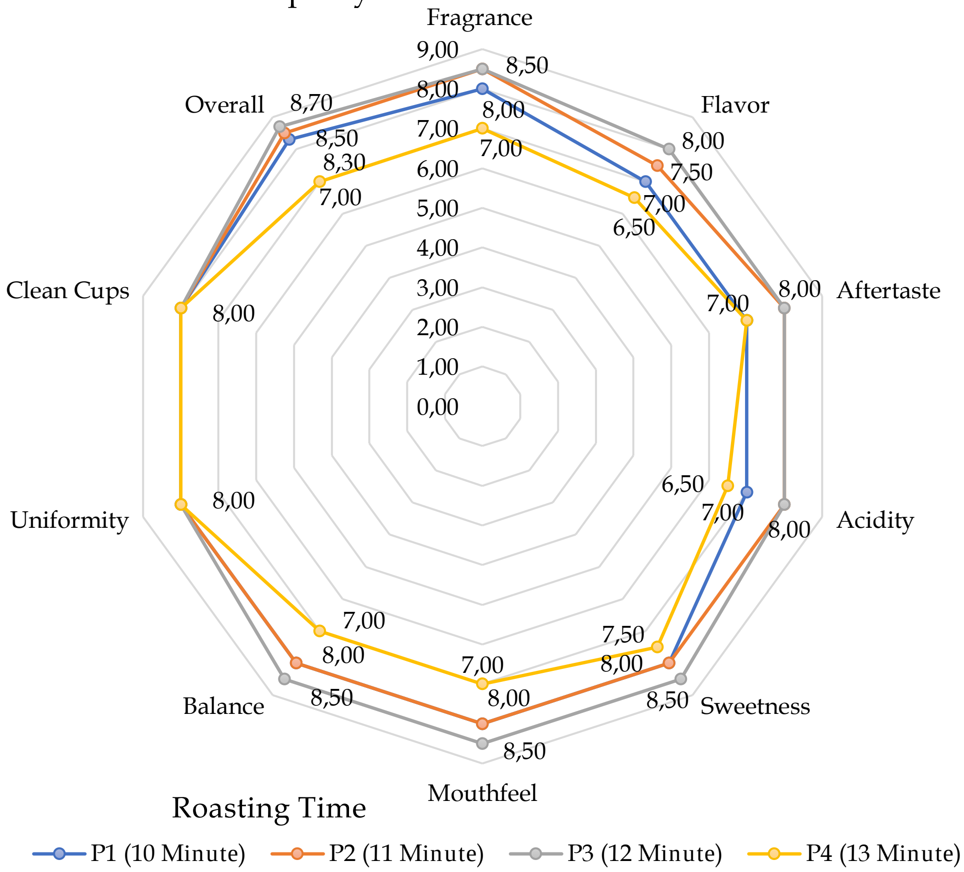


Figure 5. Robusta Coffee Flavor Profile with Variations in Roasting Time.

Table 7. Character and flavor scale of robusta coffee with variations in roasting time

Parameter	Length of Roasting Time			
	P1 (10 Minute)	P2 (11 Minute)	P3 (12 Minute)	P4 (13 Minute)
Final Score	8,10	8.30	8.50	6.80
Taste Scale	Fine	Fine	Fine	Good
Flavor Character	Nutty Good Fragrance Mild Body Low Acid Low Bitter Good Sweetness Low Salty	Medium Sweet Medium Body Cinnamon Low Bitter Low Nutty Bright Acidity Good Aftertaste	Medium Body Mild Acid Good Sweetness Sweet Choco Long Aftertaste Strong Fragrance Good Break	Smoky Chemical Detect Bold Body Black Choco Low Acid Good Mouthfeel

The spider diagram in Figure 5 shows the differences in robusta coffee with variations in the length of roasting time, which influence each taste attribute assessment given by trained panellists. According to (SCAA, 2015), there are ten assessments of taste attributes in coffee: *Fragrance/* Aroma, *Flavor, Aftertaste, Acidity, Sweetness, Mouthfeel, Balance, Uniformity, Clean Cups* and *Overall*.Water content

Fragrance/aroma is essential in assessing brewed coffee's quality. Based on Figure 5, the fragrance /aroma attribute assessment ranges from 7.00 - 8.50. The highest value for the *fragrance* /aroma attribute was obtained in the roasting treatment of 11 and 12 minutes, with the scale of 8.50 (*Fine*). Ilham et al. (2021) stated that the longer the roasting takes, the more volatile compounds will evaporate, thus affecting the aroma of the coffee beans. According to Saloko et al. (2019), the aroma produced during the roasting process can be caused by the presence of volatile and non-volatile compounds from the *Maillard reaction* formed during the roasting process, which is supported by the use of temperature and roasting time. According to Purnamayanti et al. (2017). The Maillard reaction from the coffee roasting process can cause an increase in coffee aroma. The better the quality of the coffee, the better the aroma of the coffee produced (Setyani et al., 2018). Different temperature processes and variations in roasting time will produce different flavours, this process plays a very important role in the formation of the distinctive aroma and taste of roasted coffee *beans*. The taste of coffee can vary depending on how the roasting process is carried out. Roasting at temperature 200°C for 10 minutes produces well-roasted coffee beans (Puspitasari, 2020) .

The second taste attribute is *flavour*. *Flavour* or taste is an important attribute that influences a person's acceptance of a drink, and this taste will influence the high demand for coffee drinks (Widyasari et al., 2023). Based on Figure 5, the flavour attribute assessment *ranges from* 6.50 - 8.00. The highest value for the *flavour attribute* was obtained in the 12-minute roasting treatment, which was 8.00 (*Fine*). According to Tyas (2019), The resulting flavour or taste is formed from a combination of sour, bitter and sweet flavours formed during the roasting process, which is caused by the degradation of the constituent components to *form a single unit.*

The third taste attribute is an *aftertaste*. Testing the *aftertaste attribute* on ground coffee samples is identified when the cupper takes the first sip of brewed coffee. The *cupper's* multisensory perception assesses that the fewer flavours left behind, the better the quality of the coffee (Widyasari et al., 2023). Based on Figure 5, the assessment of the aftertaste attribute *is* in the range of 7.00-8.00. The highest value for the *aftertaste attribute* was obtained in the long roasting treatment of 11 and 12 minutes, amounting to 8.00 (*Fine*). According to Saleh et al. (2020), the *aftertaste* has a favourable taste quality that remains (taste and aroma) from the back of the oral cavity and remains after the coffee is removed from the mouth or swallowed. The bitter taste due to caffeine content can affect all taste attributes, including the *aftertaste attributes* of coffee brewing (Kreuml et al., 2013).

The fourth taste attribute is *acidity*. A high score is given if the coffee has an acidity level that meets the standards (Maligan, 2022). Based on Figure 5, *the acidity* flavour attribute assessment ranges from 6.50 - 8.00. The highest value for the *acidity attribute* was obtained in the long roasting treatment of 11 and 12 minutes, amounting to 8.00 (*Fine*). According to research by Yulia (2018), the acidity level of the coffee produced is also different, ranging from low to medium and high. This level of acidity can also be felt when tasting coffee. The taste obtained is usually immediately broken down. In the research of Fauzi et al. (2016), making instant ground coffee using Robusta ground coffee does not cause a change in the sour taste of the powder, but the sour taste is caused by the presence of organic acids in the coffee. The more organic acids there are, the more acidic properties of coffee will increase (Hayati et al., 2012).

The fifth taste attribute is *sweetness*. The opposite of sweet in this context is *sour*, *astringent,* or raw. *Sweetness* differs from sucrose found in soft *drinks* (Rini et al., 2017). Based on Figure 5, the assessment of the *sweetness taste attribute* in all treatments is in the range of 7.50 - 8.50. The highest value for the *sweetness attribute* was obtained in the 12-minute-long roasting treatment, which was 8.50 (*Fine*). The sweet taste of brewed coffee is obtained because it results from the roasting process due to the *Maillard* and caramelization processes. The sweet taste of brewed coffee can also be influenced by the level of roasting of the coffee beans (Widyasari et al., 2023).

The sixth taste attribute is *mouthfeel*. Based on Figure 5, the *mouthfeel taste attribute assessment* ranges from 7.00 - 8.50. The highest value for the *mouthfeel attribute* was obtained in the long roasting treatment of 12 minutes, amounting to 8.50 (*Fine*). Coffee with an intense mouthfeel will get a high score, while a light mouthfeel will get a low score but will still have a pleasant taste (Rini et al., 2017). According to, low caffeine levels will affect lower *mouthfeel values.* Following this research, low caffeine levels were obtained in the 13-minute roasting treatment, and the lowest *mouthfeel value* was also obtained at 13 13-minute roasting time of 7.00. The thicker the coffee, the more it is liked by consumers because the thickness of the coffee can influence its strong taste (Tari et al., 2022).

The seventh taste attribute is *balance*. Based on Figure 5, the assessment of the *balanced taste attribute* for all treatments is in the range of 7.50 - 8.50. The highest value for the *balance attribute* was obtained in the treatment with a roasting time of 12 minutes, amounting to 8.50 (Fine). Coffee with good tasting quality has a pleasant sensation with a balanced *mouthfeel and aroma.* Attributes will affect the coffee *balance* if one of the attributes has less or more value (SCAA, 2015). Adam et al. (2022) also stated that if the coffee assessment has an unbalanced taste, the assessment will undoubtedly be low.

The eighth taste attribute is *uniformity*. Based on Figure 5, the assessment of the *uniformity* taste attribute in each treatment is the same, namely 8.00 (*Fine*), meaning that each cup sample has the same uniform taste and aroma. Uniformity refers to the consistency of the taste of the various sample cups. The value will be low if each cup or cup has a different taste. The complexity of coffee taste arises from various influences ranging from cultivation to processing and preparation (Sunarharum, 2014). The roasting process has a big influence in developing specific organoleptic properties that are significant for uniformity (*fragrance*, *flavour* and color) which is the basis of coffee quality (Vinanjana, 2023).

The ninth flavour attribute is *clean cups*. *Clean cups* refer to coffee *flavours* free from defects and contamination, such as fermented fruit flavours, earthy aromas, and strong aromas from coffee bean defects (Novita et al., 2010). Based on Figure 5, the assessment of the taste attribute of *the clean cups* in each treatment is the same, namely 8.00 (*Fine*). According to, if there is no negative value at the start of the coffee taste test until the aftertaste, you will get a good score, and vice versa.

The tenth flavour attribute is *overall*. Based on Figure 5, the *overall* taste attribute assessment for all treatments is 7.00 - 8.70. The highest value for the *overall attribute* was obtained in the treatment with a roasting time of 12 minutes, amounting to 8.70 (Fine*)*. Coffee with a high overall value for taste aspects will have a high *overall value* (Rini et al*.,* 2017). The higher the *value*, the more the coffee meets the expected criteria (Afriliana, 2018). Panellists liked brewing coffee with a long roasting time of 12 minutes because it produced aroma, color and taste that matched the individual panellists' preference level (SCAA, 2015).

Cupping score assessment of the quality of the taste of Robusta coffee beans is obtained from the average results of sensory testing of *fragrance* /aroma, *flavour*, *aftertaste*, *acidity*, *mouthfeel*, *balance*, *uniformity*, *clean cups* and *overall,* for each treatment. The *cupping score* results are used to determine the classification of the taste quality of the coffee beans. Table 7 shows that variations in the length of roasting time have a different influence on each assessment of all flavour attributes. The highest *final score* was obtained at a roasting time of 12 minutes, with a value of 8.50 in the *fine category*. The roasting time is 11 minutes to get *the result score* 8.30 in the *fine category*. The roasting time is 10 minutes to get *the result score of* 8.10 in the *fine category*. And the roasting time of 13 minutes got *a final score of* 6.80 in the *good category*. A sample with many attributes rated as pleasant but not particularly in line with a taster's expectations will receive a low score (Thalia et al*.,* 2020). The *cupping test* results show that the Robusta coffee in Tebat Island Village, Rejang Lebong Regency, is included in the quality of *fine* robusta. Rice coffee from higher-growing areas has a better taste, with scores for *flavour*, *fragrance* and *acidity attributes* tending to be higher than those from lower-growing areas.

CONCLUSION

Robusta rice coffee from the Tebat Pulau Village Farmers Group has large coffee beans with a water content value of 9.00%, many *peaberry beans*, and several defects of 13.83, included in quality category 2. Ground coffee samples with long roasting time significantly affect water content, color, ash content, coffee essence and caffeine content. The longer the roasting takes, the lower the water content will be, the color of the ground coffee will be darker, and the caffeine content will decrease, but the ash content and coffee juice content will increase. The quality of the coffee beans, the high percentage of *peaberry beans* and the length of roasting time are thought to have contributed to the quality of the robusta coffee brewed by the Tebat Island Farmer Group. The best quality of brewed coffee is obtained with a roasting time of 12 minutes with a *final score of* 8.50, which is included in the " *fine*" *category. The flavour* characteristics are *medium body, mild acid, good sweetness, sweet chocolate, long aftertaste, strong fragrance,* and *good break*.

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