

# Exploration and evaluation of robusta coffee quality in Merangin Regency, Jambi Province

B. Martono<sup>1\*</sup>, N. K. Izzah<sup>1</sup>, and M. S. D. Ibrahim<sup>1</sup>

<sup>1</sup>National Research and Innovation Agency, Research Center for Horticultural and Estate Crops, Research Organization for Agriculture and Food, Cibinong Science Center, Jl. Raya Jakarta-Bogor, Cibinong, Bogor 16915, West Java, Indonesia

**Abstract.** Jambi known as one of the Robusta coffee producing areas in Indonesia. Many of promising Robusta coffee clones were found at coffee plantations in Jambi and have adapted to local agroecosystems. The study aimed to evaluate the quality of Robusta coffee in Merangin Regency, Jambi Province. The exploration and evaluation were carried out in July 2020 and December 2021 using the survey method. In this study, several Robusta coffees clones that had developed in the community were found, such as Prima, Tugusari Kuning, Bengko, Mendo, and Tugusari Hijau. These clones are preferred because they have good taste and high productivity as well as adaptive in the highlands. The result of cupping test for Prima, Bengko, Local, Tugusari Kuning, Mendo, and Tugusari Hijau clones showed a final score of >80 (Fine Robusta) with a final score ranging from 80.50-81.63, while Parabola and Curup clones were categorized as not specialty with the score of 70.50 and 78.375, respectively. On the other hand, the results of caffeine content analysis of the Curup, Mendo, Parabola, Tugusari Hijau, and Tugusari Kuning clones ranged from 1.33-1.74%. This initial evaluation is expected to provide an overview of the existence of promising Robusta coffee clones in Jambi. Hence, these coffee clones can be developed as local superior clones in the future.

## 1 Introduction

The International Coffee Organization stated that world coffee consumption and production continues to increase. The consumption in 2020-2021 was 166.35 million sacks, an increase of 1.31% compared to the previous year's consumption of 164.20 million sacks. Meanwhile, the total coffee production in 2020-2021 reached 169.63 million sacks or an increase of 0.47% from 168.83 million sacks in 2019-2020 [1], thus coffee has an important role in improving the economy of farmers and a source of foreign exchange for many developing countries. In Indonesia, Robusta coffee dominates about 90% of the coffee plantation area. The area of Robusta coffee reaches 862,108 ha, 27,365 ha of which is in Jambi Province spreading over several Regencies/Cities, and the largest is in Merangin Regency reaching 11,066 ha [2, 3].

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\* Corresponding author: [budi077@brin.go.id](mailto:budi077@brin.go.id)

Merangin Regency is located around the Masurai Mountains at an altitude of 800 to 1,400 m above sea level with a hilly topography, making Merangin Robusta coffee has a specific taste. This is evidenced by the achievements obtained as the best Robusta coffee at the 8th SCAI Micro Lots Indonesia Specialty Coffee Auction 2018 event in Bali and in 2019 at a similar event in Bandung. As an effort to improve the competitiveness, added value, and to gain recognition for the quality and the uniqueness of its products, the Robusta coffee farming community in Merangin Regency as joined the Society Protection of Geographic Indication of Masurai Robusta Coffee Sei. Tenang 'Jangkat' (MPIG Kopi Robusta MS'J).

The main problem in Robusta coffee cultivation is the lack of availability of seeds from superior varieties for plant propagation because the use of random seeds will produce plants that have different genetic characteristics from the parent. Therefore, Robusta coffee plant propagation is recommended to be conducted by vegetative methods [4]. In addition, the farmers generally still used random seeds. The selection of plant material is only based on physical factors of the seeds without regard to the genetic factors. It is assumed to be one of the causes of low coffee productivity. The average coffee productivity in Jambi is only 1050 kg/ha [2], much lower than the potential productivity of high-yielding varieties which reach 3,300 kg/ha/year [5].

Varied cropping patterns in each location represent very good potential in terms of the source of genetic diversity that will be generated. The climate which tends to be wet in the highlands in smallholder plantations has in fact a number of promising Robusta coffee clones with specific characteristics. One of them is the existence of various types of Robusta coffee clones that are specific to location, climate, soil type, and social aspects of the community. These clones were selected naturally in the community's cropping pattern and have adapted to the environment as well as the climate in Merangin Regency. To increase the productivity of Robusta coffee, the farmers in Merangin Regency developed local superior clones by grafting, using plagiotropic branches obtained from selected superior coffee clones. This study aimed to explore and to evaluate Robusta coffee clones spread across Merangin Regency.

## **2 Methods**

### **2.1 Time and place**

The study was conducted in July 2020 and December 2021. The exploration and evaluation were carried out in Merangin Regency which included Jangkat Sub-district consisted of Pulau Tengah (Danau Paoh and Renah Mentelon) and Koto Renah Villages. Lembah Masurai Sub-district covered Dusun Tuo and Nilo Dingin Villages and Sub-district Jangkat Timur (Simpang Talang Tembago Village). The location of the study was selected intentionally (purposive sampling) based on the consideration that the three sub-districts are the largest coffee-producing areas in Merangin Regency. The cupping test was carried out at the Indonesian Coffee and Cocoa Institute Laboratory, while the caffeine analysis was carried out at the Integrated Laboratory of the Indonesian Industrial and Beverage Crops Research Institute (IIBCRI).

### **2.2 Exploration and evaluation**

The study was initiated by conducting a survey to areas identified as centers of Robusta coffee production. Data collection of Robusta coffee clones was carried out by breeders assisted by the staffs from the Plantation Service of Jambi Province, the Livestock and Plantation Office of Merangin Regency, the head of farmer groups, and the farmers who

owned the plantation. The identification and evaluation of the coffee clones was based on morphological characters, cupping test and caffeine content.

### **2.3 Morphological characterization**

The observations of plant from seeds were conducted on on the quantitative and the qualitative morphological characters. Some of the characters observed referred to description [6, 7], including leaf characters (leaf length, leaf width, ratio of leaf length and width, petiole length, leaf shape, leaf apex, the color of shoots, top surface and bottom of the leaves, petiole color), and fruit (length and width of fruit, fruit thickness, fruit color, fruit shape, presence/absence of fruit ribs, weight of 100 fresh fruits, and pulp thickness).

### **2.4 Cupping test**

The brewing quality test was carried out on 8 coffee clones, including Parabola, Curup, Prima, Bengko, Local, Tugusari Kuning, Mendo, and Tugusari Hijau. The coffee beans were processed naturally then processed into ground coffee. Cupping test referring to the standards and protocols for fine Robusta compiled by the Uganda Coffee Development Authority and the Coffee Quality Institute [8].

The assessment of the sensory attributes of the coffee was carried out by 3 panelists. The cupping test components observed included the attributes of aroma when brewed (aroma), taste on the tongue (flavor), the taste remained in the mouth (aftertaste), acidity, sweetness, viscosity (body), uniformity of the taste of each cup (uniformity), aspects of the taste balance (balance), general taste impressions (clean cup), and aspects of overall taste (overall). The panelists assessed each sensory attribute with a score of 6.00 to 6.75 (good); 7.00 to 7.75 (very good); 8.00 to 8.75 (excellent), and 9.00 to 10.00 (outstanding). The final score was obtained by adding up the score of each attribute, if the value is  $\geq 80$  on a scale of 100 based on the cupping test, it can be categorized as fine Robusta coffee.

### **2.5 Caffeine analysis**

The analysis of the caffeine content of coffee beans was carried out on Curup, Mendo, Parabola, Tugusari Hijau, and Tugusari Kuning clones using the chromatography-spectrophotometry method based on the procedure of the Association of official Analytical Chemists [9].

### **2.6 Data analysis**

The data obtained from morphological observation were analyzed descriptively by calculating the average value, the standard deviation, and the coefficient of diversity. The analysis was carried out using the Excell Program.

## **3 Results and discussion**

### **3.1 The exploration and evaluation of robusta coffee**

Based on the identification of Robusta coffee clones in Danau Poah, Pulau Tengah Village, most of the clones developed were from outside of the Merangin Regency, such as from the provinces of Lampung, Bengkulu, and Jember. This can be seen from the many clones of

Tugusari Hijau, Tugusari Kuning, Prima, Curup, Parabola, Mendo, and Bengko as in the farmers' gardens. In addition, the local clones with low and unstable production were also found. However, according to the information obtained, the local clones have the advantage of better taste compared to other clones, long life, and relatively resistant to the pests/diseases.

The first local clone of Robusta coffee found was a Dutch relic which farmers called the Mantadu clone. This clone is characterized by small fruit size, wide bunch spacing, and medium size leaves. These clones are no longer cultivated due to low production and are only found on the outskirts of the garden. Moreover, another local clone called Kopi Lanang was also obtained. It was called kopi lanang because it produces fruit with a high percentage of single beans. Kopi Lanang has specific characteristics, its leaves and fruit are brownish.

Male coffee (*Pea berry coffee*) is coffee with whole round seeds or also called one-seeded fruit. The increase of pea berry rate occurred due to the cultivation of unsuitable clones as well as a decrease in the fertilization rate which resulted in low yield and quality of coffee beans [10, 11]. These seeds are actually formed as a result of an abnormal fruit formation process. This abnormality is caused by the fact that not the entire process of fruit formation running perfectly, causing irregularities in coffee beans. The fruit has two ovules, but one of the ovules fails to develop while the other ovules develop well and occupy the entire cavity of the ovule. Male coffee has a high quality of taste but limited quantity. The number of male coffee ranges from 3-5% of the total number of coffee beans in one tree, thus the selling price of male coffee becomes more expensive [12].

Tugusari Hijau, Tugusari Kuning, Prima, Curup, Parabola, and Bingo clones generally have high production, so they are usually used as sources of plagiotropic branches. These coffee clones are the result of participatory breeding. Participatory breeding is a plant breeding program that actively involves users of breeding products, including farmers, traders, processors and consumers [13]. Tugusari Kuning is a clone originating from Lampung, while Prima and Bengko clones are thought to have originated from Pagar Alam area, South Sumatra. Coffee farmers propagate conventionally by grafting on production trees using plagiotropic branches (tak-ent). Through this method, there was an increase in production from 400 kg/ha to 1,500 kg/ha/year.

The findings of exploration in Pulau Tengah Village and Koto Renah Village are several coffee clones, including Prima, Parman, Tugusari Hijau, Bengko, Parabola, Jember, and the local clones. The Prima clones are widely cultivated because of their high production, plenty of inter-fruits, and faster fruiting season. The Tugusari Hijau clone has a slower harvesting season compared to that of other clones, while the Bengko clone had the characteristics of long fruit with many young fruits that fell off before maturing so that it could reduce yields.

The results of exploration in Dusun Tuo Village and Nilo Dingin Village, Sub-district of Lembah Masurai, Koto Renah Village, Jangkat Sub-district, and Simpang Talang Tembago Village, Jangkat Timur Sub-district, revealed that most Robusta coffee farmers planted coffee seeds from non-recommended varieties/clones. Robusta coffee is self-incompatible in nature, so it tends to cross-pollinate [14, 15]. The barrier to self-pollination is caused by cessation of pollen tube development, which makes fertilization of the female gametophyte impossible [16, 17]. This is due to the action of ribonucleases that degrade ribosomal RNA, inhibiting pollen tube growth [18, 19]. Robusta coffee is classified as a cross-pollinated plant that is highly heterozygous, so that the offspring generated from the seed showed the diversity among the observed Robusta coffee plants (Table 1 and Table 2). This diversity is very beneficial, because by selecting a diverse population it is possible to obtain superior clones [20].

The results of interviews and field observations indicated that farmers have carried out selection activities. The farmers' groups in Simpang Talang Tembago Village, Jangkat Timur Sub-district, have selected the Robusta coffee population around them. The selection results

obtained several clones, including the clones of Unyil, Bodong, Awang, Dayat, and Marjuki. Unyil clones have the characteristics of small dense fruit, medium bunch segment, sweet fruit taste, small leaves, and red ripe fruit color; Bodong clones have large, rather long fruits, prominent discs, young fruit with thin lines, closely spaced bunches, small leaves with green color; Awang clone bears large, flattened, well-lined, slightly spaced bunches, and small discus; Dayat clones bear large fruit, young green fruit and thin stripes, small discus, green-brownish leaf shoots, slightly wide and wavy leaves; while Marjuki clones have rather large round fruits, young fruits are dark green and unlined, fruit bunches are less dense, leaf shoots are brownish, broad wavy leaves. However, it is unfortunate that the selected clone based on these superior characteristics have not been widely developed.

The plagiotropic bud grafting is one of the innovations that are cheap, efficient, effective, and easy to increase productivity both in quality and quantity. The rootstock used is usually Robusta coffee from seeds that have been planted previously. In addition to using Robusta coffee as rootstock, farmers in Lembah Masurai Sub-district also used rootstock from Excelsa coffee. Excelsa coffee is known to be less economical and commercial because it has many variations in the shape and size of the beans as well as the quality of taste.

The results of observations in Nilo Dingin Village, Lembah Masurai Sub-district and Koto Renah Village, found the populations of Robusta coffee which were grafted using fruit branches (plagiotropic branches) using Tugusari Hijau and Tugusari Kuning clones from Bengkulu. The benefit of grafting coffee plants using plagiotropic branches is to take advantage of the superior characteristics of fruit branches that have high production and good quality beans, hence the coffee plant will bear fruit quickly.

Lembah Masurai Sub-district, Jangkat Sub-district and Jangkat Timur Sub-district are highlands with altitudes above 1,000 m above sea level, making them suitable for growing Arabica coffee. However, the reality in the field showed that the cultivation of Arabica coffee in this area is still very limited. This is of course an important note for related stakeholder to start planning Arabica coffee in the area. Of which, the selection of varieties can be adjusted to the altitude and the type of climate.

### **3.2 Morphological characterization**

The results of qualitative characters observed on Robusta coffee from beans in Dusun Tuo Village, Lembah Masurai Sub-district showed that all clones had green petiole color and lines were found on the fruit. The diversity of morphological characters can be seen in the young shoot color, the color of the upper and lower surface of the leaf, the shape of the tip of the leaf, the leaf shape, the color of the fruit, the shape of the fruit, and the thickness of the pulp of the fruit (Table 1).

The results of the descriptive analysis showed the diversity of several quantitative characters observed (Table 2). The highest diversity is seen in the weight of 100 fruits character with a coefficient of diversity value of 28.78%. Meanwhile, for the petiole length, fruit length, ratio of leaf length and leaf width, fruit width, leaf length, and fruit thickness, the diversity ranged from 6.89 to 13.76%.

**Table 1.** Qualitative character of leaves and fruits observed from 13 Robusta coffee clones derived from Lembah Masurai Sub-district, Merangin Regency, Jambi Province.

Accession	Young shoot colour	Upper surface of the leaf	Lower surface of the leaf	Leaf apex shape	Leaf petiole colour	Leaf shape	Fruit colour	Fruit shape	Absence/presence of fruit ribs	Pulp thickness
1	Green	Dark green	Green	Apiculate	Green	Elliptico-oblongus	Red	Roundish	Present	Intermediate
2	Green	Dark green	Green	Acuminate	Green	Elliptico-oblongus	Orange-red	Roundish	Present	Thick
3	Brownish green	Green	Greenish	Apiculate	Green	Elliptico-oblongus	Red	Elliptic	Present	Thin
4	Green	Dark green	Green	Apiculate	Green	Elliptico-oblongus	Red	Roundish	Present	Thick
5	Green	Dark green	Green	Acuminate	Green	Elliptico-oblongus	Red	Roundish	Present	Thick
6	Brownish green	Dark green	Green	Apiculate	Green	Elliptico-oblongus	Red	Roundish	Present	Intermediate
7	Green	Dark green	Green	Apiculate	Green	Elliptico-oblongus	Red	Obovate	Present	Intermediate
8	Green	Dark green	Greenish	Acuminate	Green	Ellipticus	Red	Roundish	Present	Intermediate
9	Brownish green	Green	Greenish	Acuminate	Green	Elliptico-oblongus	Orange-red	Roundish	Present	Thick
10	Brownish green	Green	Greenish	Acuminate	Green	Elliptico-oblongus	Red	Roundish	Present	Thin
11	Green	Green	Greenish	Apiculate	Green	Elliptico-oblongus	Red	Obovate	Present	Intermediate
12	Green	Dark green	Green	Acuminate	Green	Ellipticus	Orange-red	Obovate	Present	Thick
13	Brownish green	Green	Light green	Apiculate	Green	Elliptico-oblongus	Orange-red	Roundish	Present	Intermediate

**Table 2.** Quantitative characters of the leaves and fruits observed from 13 Robusta coffee clones obtained from Lembah Masurai Sub-district Merangin Regency.

Accession	Leaf length (cm)	Leaf width (cm)	Ratio	Petiole length (cm)	Fruit length (mm)	Fruith width (mm)	Fruit thickness (mm)	Weight of 100 fresh fruits
1	17.24	8.25	2.09	1.04	18.46	15.66	14.74	196.30
2	20.26	9.86	2.06	1.06	18.76	17.83	16.91	273.83
3	19.63	8.43	2.33	1.06	17.05	14.01	12.34	98.44
4	18.80	8.02	2.34	1.02	20.04	19.14	17.91	197.96
5	21.85	9.22	2.37	1.04	17.75	16.31	15.20	127.03
6	16.18	7.54	2.15	0.90	17.75	14.78	14.46	139.27
7	17.04	8.46	2.01	0.82	18.40	17.07	14.95	193.70
8	19.23	10.89	1.77	1.02	16.24	14.79	13.78	134.33
9	20.81	10.23	2.03	1.02	17.98	17.22	16.59	165.00
10	20.65	9.24	2.24	1.05	14.96	14.76	12.09	133.13
11	19.63	8.45	2.32	1.04	18.66	15.08	13.45	197.67
12	19.83	10.02	1.98	1.02	19.79	17.43	15.88	232.25
13	25.03	12.00	2.09	1.02	16.12	14.64	13.24	136.56
Total	256.18	120.61	27.78	13.11	231.96	208.72	191.54	2225.47
Average	19.71	9.28	2.14	1.01	17.84	16.06	14.73	171.19
Standard Deviation (SD)	2.27	1.28	0.18	0.07	1.45	1.56	1.77	49.27
Coefficient of variation (%)	11.54	13.76	8.31	6.89	8.14	9.72	11.99	28.78

### 3.3 Cupping test

The results of the organoleptic test based on dry processing under full sunlight (natural) showed that the Mendo clone had better taste components than the other 7 clones (Table 3). This clone has higher aftertaste, acidity, bitterness, balance, and overall. The characteristics of aroma (fragrance), taste (flavor), acidity, and viscosity (body) are very good with values ranging from 7.83-8.00 accompanied by brown sugar, spicy, chocolaty, nutty, and tobacco flavors. However, the taste of Mendo clone has not yet surpassed the taste of Kobura 1, Kobura 2, and Kobura 3 clones which are known as clones with Excellent taste (final score 84-88) [21].

The Robusta coffee analyzed showed a high score of uniformity (uniform cup) and taste cleanliness (clean cups) with a score of up to 10. The results of the cupping tests of Robusta coffee clones of Prima, Bengko, Local, Tugusari Kuning, Mendo, and Tugusari Hijau produced a quality brewed product with fine Robusta category with a final score of >80 or ranging from 80.50 to 83.32; while that of the Parabola and Curup clones were 70.50 and 78.375, respectively (Not specialty). The difference was influenced by many factors, one of which is the harvesting process and post-harvest handling. To obtain the optimal taste quality, it is recommended that coffee cherries harvested are picked red, or sorting the fruit after harvest to separate the ripe red fruit from the green ones.

**Table 3.** The cupping test results of several Robusta coffee clones derived from Merangin Regency which processed naturally.

Flavor components <sup>a</sup>	Robusta coffee clones							
	Parabola	Curup	Prima	Bengko	Local	Tugusari Kuning	Mendo	Tugusari Hijau
Fragrance	6.88	7.50	7.75	7.75	7.75	7.92	7.92	7.67
Flavor	6.75	7.50	7.75	7.65	7.83	7.92	7.83	7.58
Aftertaste	6.75	7.125	7.63	7.42	7.75	7.75	7.92	7.42
Acidy	7.13	7.125	7.50	7.58	7.83	7.67	7.90	7.58
Bitterness	7.00	7.125	7.50	7.58	7.67	7.67	7.92	7.50
Body	7.25	7.50	8.00	7.67	7.83	8.00	8.00	7.75
Uniform	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Balance	7.00	7.25	7.75	7.42	7.75	7.83	7.92	7.58
Clean cup	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Overall	6.75	7.25	7.75	7.42	7.83	7.75	7.92	7.58
<b>Final score</b>	<b>70.50</b>	<b>78.375</b>	<b>81.63</b>	<b>80.50</b>	<b>82.25</b>	<b>82.50</b>	<b>83.32</b>	<b>80.67</b>

<sup>a</sup> Good = 6.00-6.75; Very good = 7.00-7.75; Excellent = 8.00-8.75; Outstanding = 9.00-9.75

**Table 4.** Aroma characteristics of 8 Robusta coffee clones derived from Merangin Regency.

Clone	Aroma characteristics																		
	1 <sup>a</sup>	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Parabola	v <sup>b</sup>	v	v	v	v	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Curup	v	-	-	-	-	v	v	-	-	-	-	-	-	-	-	-	-	-	-
Prima		-	-	-	-	v	v	-	-	-	-	-	-	-	-	-	-	-	-
Bengko	v	-	-	-	-	v	-	v	v	-	-	-	-	-	-	-	-	-	-
Local	v	-	-	-	-	v	-	v	v	v	v	v	v	-	-	-	-	-	-
Tugusari Kuning	-	-	-	-	-	v	v	-	-	v	-	v	v	v	v	v	-	-	-
Mendo	-	-	-	-	-	v	v	v	-	v	-	-	-	v	-	-	-	-	-
Tugusari Hijau	v	-	-	-	-	v	-	v	-	-	-	v	v	-	-	-	v	v	v

<sup>a</sup>1. Caramelly, 2. Herbal, 3. Fermented, chocolate 4. Bitter, 5. Natural, 6. Spicy, 7. Chocolate, 8. Nutty, 9. Black tea, 10. Brown sugar, 11. Greenish, 12. Astringent, 13. Coffee pulp, 14. Tobacco, 15. High body, 16. Balance, 17. Stale, 18. Flat, 19. Rather dirty, <sup>b</sup>Detected.

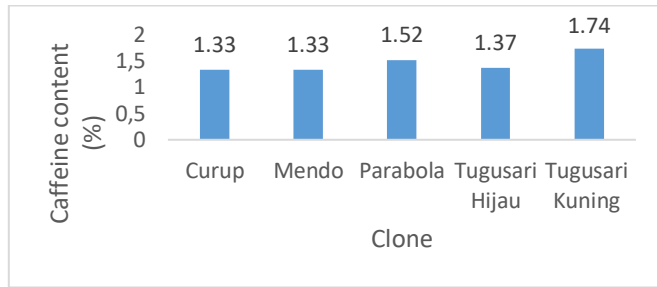
The aroma character of each clone has its own specifications, for example, the aroma characters of caramelly, herbal, fermented chocolate, bitter, and natural were found in the Parabola clone; while the aroma of caramelly, spicy, and chocolate was detected in the Curup clone. The characteristic taste of herbal coffee was found in Parabola clones, while greenish was found in local clones. Spicy coffee flavor was found in all clones except Parabola clones (Table 4).

### 3.4 Caffeine content of coffee beans

Analysis of caffeine content of several Robusta coffee clones in Merangin Regency showed varying results (Fig. 1). The average caffeine content of coffee bean samples was 1.46% or ranged from 1.33-1.74%. The lowest caffeine levels were detected in Curup and Mendo clones (1.33%), while the highest was in Tugusari Kuning clones at 1.74%.

The caffeine content in Robusta coffee beans in this study was in accordance with the range of the previous research. According to the existing literature, the caffeine content of dry Robusta coffee is 1.10-2.80% of dry weight [22, 23, 24]. Caffeine content is influenced by the type and origin of coffee, soil type, altitude and temperature, cultivation method, climatic and environmental conditions, storage time and conditions, and processing of beans, including cleaning and roasting process [25-34]. Differences in reported caffeine content may result from the measurement method [35] and may also be influenced by cherry maturity at harvest and non-coffee additives. The caffeine content of pure ground coffee produced from a mixture of green and yellow beans from the same type of coffee tends to be low [36].





**Fig. 1.** Caffeine content of 5 Robusta coffee clones.

## 4 Conclusion

The results of exploration were Tugusari Hijau, Tugusari Kuning, Prima, Curup, Parabola, Bengko, Parman, Jember, Mendo, and local clones. The organoleptic tests on 8 clones showed that Prima, Bengko, Local, Tugusari Kuning, Mendo, and Tugusari Hijau clones produced brewed quality products with scores ranging from 80.50-83.32 (Fine Robusta); while Parabola and Curup clones were 70.50 and 78.375, respectively. The caffeine content of Curup, Mendo, Parabola, Tugusari Hijau, and Tugusari Kuning clones ranged from 1.33-1.74%.

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