

Physicochemical And Organoleptic Characteristics Of Cold Brew Robusta Coffee (Coffea Canephora) From Temanggung Based On Roasting Process

Shafa Nur Alifia Salsabila, Novian Wely Asmoro *, Agustina Intan Niken Tari

Abstract: Roasting and brewing significantly influence the flavor and characteristics of coffee. Factors affecting the roasting process include the roasting machine, temperature, and duration of roasting. Cold brew brewing is the extraction of coffee using cold water, stored at temperatures below 30°C for 12 to 24 hours. This study aims to determine the physicochemical characteristics, particularly caffeine content and pH, followed by organoleptic testing compared to commercial coffee with 30 panelists on parameters (flavor, bitterness, aroma, color, overall) of Temanggung robusta coffee cold brew. The research employed a Completely Randomized Design (CRD) with variations in roasting levels. The temperatures and times used for the roasting levels were: light roasting at 210°C for 7 minutes, medium roasting at 215 °C for 9 minutes, and dark roasting at 225 °C for 11 minutes. The data were statistically analyzed using analysis of variance (ANOVA) followed by the Duncan Multiple Range Test (DMRT) at a significance level of 5% using SPSS 27. The results showed that the caffeine content of Temanggung robusta coffee cold brew ranged from 489.18 to 735.87 mg/L. The average pH was found to be between 5.72 and 5.96. In the organoleptic test, panelists provided differing scores on aroma and color parameters, with average scores ranged from 2.5 (not quite sharp) to 3.3 (fairly sharp).

Keywords: brewing, coffee, cold brew, roasting

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Riwayat artikel

Dikirim: 08-11-2024; Diterima: 20-11-2024; Direvisi: 12-11-2024; Diterbitkan:01-12-2024

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DOI: 10.30595/agritech.v26i2.24426

Agritech: Jurnal Ilmu-Ilmu Pertanian Diterbitkan oleh Fakultas Pertanian dan Perikanan Universitas Muhammadiyah Purwokerto Gedung J, Lt.3, Kampus 1, Jl. KH. Ahmad Dahlan, Dusun III, Dukuhwaluh, Kec. Kembaran, Kabupaten Banyumas, Jawa Tengah 53182, Telp. (0281) 636751

Introduction

Coffee is a beverage produced by processing coffee beans that have been roasted and ground before brewing (Pangabean, 2011). Coffee's unique flavor and aroma make it one of the most popular beverages in the world, with benefits to increase energy and concentration due to the content of complex compounds such as caffeine and chlorogenic acid (Kuncoro et al., 2018). One type of coffee that is widely consumed in Indonesia is robusta coffee, which is characterized by a more bitter, slightly sour flavor and higher caffeine content compared to arabica coffee (Hakim dan Septian, 2011). Robusta coffee beans that have high quality are the Java moka or Java robusta type, which ideally grows in a low-temperature environment, fertile and ideal soil such as in the Temanggung area, Central Java (Rulinawaty, 2023).

Coffee contains several compounds including caffeine, chlorogenic acid, trigonelline, carbohydrates, fats, amino acids, organic acids, and volatile acids (Farhaty and Muchtaridi, 2016). The content of coffee compounds is influenced by the handling process during harvest and post-harvest (Edvan et al., 2016). After passing through the harvest and post-harvest handling stages, quality coffee beans will go through a decaffeination and roasting process using high temperatures, which functions to form aroma, acidity, and flavor in coffee beans (Agustina et al., 2019). Based on the roasting temperature used, roasted coffee is divided into 3 groups, namely: light roast with a temperature of 205°C, medium roast with a

temperature of 228°C (Mega, 2022). According to (Varnam & Sutherland, 1994), light roast removes 3-5% moisture content, medium roast 5-8%, and dark roast 8-14%. Roasting greatly affects the color and flavor of coffee products that will be consumed.

The brewing method is one of the important aspects of coffee making besides roasting, one of the brewing methods is cold brew, which is an extraction process using cold water or room temperature water stored below 30°C for 12-24 hours (Darmawan, 2017; Fuller & Nini, 2017). Several studies have shown that coffee brewed with hot water tends to be more acidic, while the coffee brewed with cold water produces a sweeter flavor with lower caffeine content and higher antioxidants (Miesse, 2018; Bodnariuc, 2017). In addition, the longer the cold brewing time, the chlorogenic acid content and acidity of cold-brewed coffee also increase compared to hot-brewed coffee (Fuller & Nini, 2017).

According to (Miesse, 2018) and (Bodnariuc, 2017), hot brewed coffee is more acidic than cold brewed coffee, even reducing caffeine content, increasing antioxidant content, and producing a sweeter coffee flavor. Therefore, this study was conducted to examine the effect of roasting methods on the characteristics of Temanggung robusta coffee drinks processed by cold brewing

Methods

The materials used in this study were robusta coffee from Temanggung Regency, Central Java with various roasting levels dan Commercial robusta ground coffee as organoleptic test control. Chemicals for analysis include: standard caffeine, calcium carbonate (CaCO₃), chloroform, and distilled water. The tools used are grinder latina N600 and coffee roasting machine. Tools used in testing caffeine and pH in the laboratory include analytical scales, UV-Vis spectrophotometry, rotary evaporator, pH meter, measuring cup, test tube, and separating funnel.

Sample preparation

The roasting process of coffee beans refers to the method Mega & Beta (2022) with modification. The temperature and time used in the roasting process, namely light roasting at 210°C and 7 minutes, medium roasting profile at 215°C and 9 minutes, and dark profile at 225°C and 11 minutes. In the next stage after the coffee beans are roasted, a resting process is carried out for seven days which aims to reduce carbon dioxide levels in coffee beans. Next, the grinding of coffee beans is carried out before brewing.

Temanggung robusta coffee cold brew preparation

This stage refers to previous research (Maulana, 2022) cold brew method with the ratio used 1:15 is done by adding 10 grams of coffee powder with medium coarse fineness and adding 150 grams of demineralized water dissolved in a tumbler container and cooled to a temperature of about 4 °C for 10 hours stored in the refrigerator, after which filtration is done with v60 filter paper.

Caffeine analysis

The caffeine analysis procedure referred to (AOAC, 2005) was carried out starting with the preparation of a caffeine standard curve using anhydrous caffeine and then measured by UV-Vis spectrophotometry. Making a standard curve of 0.1; 0.3; 0.6; 0.9; 1.2; 1.5 mL of a 100 ppm caffeine standard solution and diluted to 10 ml so that the obtained caffeine standard solution has the following concentrations: 1; 3; 6; 9; 12; 15 mg/L. Furthermore, the caffeine standard solution was measured using a UV-Vis spectrophotometer then the absorbance data obtained was interpreted into a standard curve.

To test the caffeine content in Temanggung robusta coffee cold brew samples, each 150 mL of cold brew was extracted with 1.5 g of calcium carbonate, 25 mL of chloroform was added three times, and then the chloroform phase was evaporated with a rotary evaporator. Next, the caffeine extract was dissolved in 100 mL of distilled water and diluted 10 times in a 10 mL volumetric flask, before being measured with a UV-Vis spectrophotometer at a wavelength of 273 nm to determine the caffeine content. The caffeine content test was repeated 6 times in each sample.

Calculation of caffeine content was done with the equation:

Caffeine content mg/L

 $= \frac{X (mg/mL) \times Total \ volume \ of \ sample \ (L) \times FP}{Weight \ of \ sample \ (mL)}$ Description : $X = Caffeine \ concentration \ (mg/mL)$ FP = The dilution factor

Acidity analysis

Determination of acidity/pH in Temanggung robusta coffee cold brew is done by measuring using a pH meter on each sample, each cold brew sample from three different roasting profiles is put into a measuring cup of 50 ml, and marked, then the pH meter is inserted into each sample and the number that comes out on the pH meter is seen.

Organoleptic Analysis

Organoleptic analysis was conducted by 30 panelists from various backgrounds, using a multiple comparison methods with a rating scale of 1-5 to compare the three Temanggung robusta coffee cold brew with the

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commercial exelso robusta coffee as a control. Panelists were asked to rate several characteristics of the three

Temanggung robusta coffee cold brew samples including taste, bitterness, aroma, color, and overall.

Tuble 1. The organoleptic assessment scale is based on the following chart.				
Flavor	Bitterness	Aroma	Color	Overall
Much more delicious than R	Much more bitter than R	Much sharper than R	Much darker than R	Like very much more than R
More delicious than R	More bitter than R	Sharper than R	Darker than R	Like more than R
Same as R	Same as R	Same as R	Same as R	Same as R
Less delicious than R	Less bitter than R	Less sharp than R	Less dark than R	Dislike more than R
Much less delicious than R	Much less bitter than R	Much less sharp than R	Much less dark than R	Dislike very much more than R
	Flavor Much more delicious than R More delicious than R Same as R Less delicious than R Much less delicious than R	FlavorBitternessMuch more delicious than RMuch more bitter than RMore delicious than RMore bitter than RSame as RSame as RLess delicious than RLess bitter than RMuch less delicious than RMuch less bitter than R	FlavorBitternessAromaMuch more delicious than RMuch more bitter than RMuch sharper than RMore delicious than RMore bitter than RSharper than RSame as RSame as RSame as RLess delicious than RLess bitter than RLess sharp than RMuch less delicious than RMuch less bitter than RMuch less sharp than R	FlavorBitternessAromaColorMuch more delicious than RMuch more bitter than RMuch sharper than RMuch darker than RMore delicious than RMore bitter than RSharper than RDarker than RSame as RSame as RSame as RSame as RLess delicious than RLess bitter than RLess sharp than RLess dark than RMuch less delicious than RMuch less bitter than RMuch less sharp than RMuch less dark than R

Table 1. The organoleptic assessment scale is based on the following chart:

Note: **R** is the control of cold brew from commercial coffee.

Statistical Analysis

This study uses a completely randomized design (CRD) with a single factor, namely the roasting method with three variations in roasting levels. Data from physical and chemical properties testing will be analyzed by ANOVA method and if there is a significant difference between treatments ($\alpha \le 0.05$), followed by DMRT (Duncan Multiple Range Test) tests using SPPS 27 application software.

Results & Discussion

The cold brew appearance of Temanggung robusta coffee

Cold brew is an innovative cold brewing method applied to coffee by soaking the coffee for 10 hours at a controlled temperature of 4°C. Using the same ratio in all three samples of 10 grams of coffee with 150 mL of demineralized drinking water to reduce the stronger taste.



Figure 1. Cold brew robusta coffee Temangggung. Description: S1 (Cold brew light roast level); S2 (Cold brew medium roast level); S3 (Cold brew dark roast level).

Temanggung robusta coffee cold brew samples from various roast levels have different colors, namely cold brew with light roast level has a light brown color, then cold brew with medium roast level has a dark brown color, while at dark roast level has a blackish brown color. This is caused by differences in the roasting process carried out on Temanggung robusta coffee beans. The results of this study aligned with the findings of Pamungkas et al. (2021), which indicated that roasting temperature and duration significantly affected the color change of coffee beans. This study showed that the higher temperature and the longer roasting time, the darker the coffee beans tended to become. This suggested that roasting temperature and duration played a key role in determining the visual characteristics of coffee, influencing both the quality and consumer perception of the final product.

Caffeine content

Caffeine is the main component in coffee that has important pharmacological effects, including clinical benefits such as central nervous system stimulation, smooth muscle relaxation, especially bronchial muscle, and heart muscle stimulation (Maramis et al., 2013). Standard Curve Regression of Caffeine and the results of the analysis of caffeine content in Temanggung cold brew robusta coffee with variations in the level of roasting process are presented in Figure 2 and Figure 3.





Standard Curve Regression Caffeine Content Test

Based on Figure 2. it can be seen that the caffeine content in Temanggung Robusta coffee cold brew has the highest average value at the dark roast level with an average value of 735.87 mg/L,



Figure 3. Caffeine Content of Temanggung Robusta Coffee Cold Brew. (Description: Light = temperature 210°C and time 7 minutes. Medium = temperature 215°C and time 9 minutes. Dark = temperature 225°C and time 11 minutes).

the caffeine content at the medium roast level with an average value of 668.33 mg/L and the lowest at the light roast level with an average value of 489.18 mg/L. In the results of this study, the temperature and duration of roasting also affect caffeine, according to the statement (Sutrisno, 2006) which states that the higher the roasting temperature, the caffeine content also increases, allegedly due to the decomposition of liquid and acidic substances so that the amount of nonliquid substances such as caffeine increases (Mulato et al., 2001). The difference in caffeine levels may be attributed to the moisture loss and concentration effect during roasting. As roasting intensity increases from light to dark, coffee beans lose a significant amount of water, leading to a denser, more concentrated product where caffeine content per unit volume increases. Although caffeine itself remains relatively stable under high roasting temperatures, the decrease in moisture and other volatile compounds results in a relative increase in caffeine concentration in darker roasts.

The caffeine content of Temanggung robusta coffee cold brew with three roasting levels (light, medium, dark) was compared to research (Alfia Purnama, 2020) which states that the caffeine content in robusta cold brew ranges from 335 to 561.72 mg/L, this is likely based on the use of different coffee in terms of postharvest, roasting, the ratio used, but the results of the Temanggung robusta coffee cold brew caffeine test still have values ranging not much different between these values.

Acidity/pH of cold brew

Factors that affect the taste of coffee are the acidity level or pH which is influenced by the fermentation process of coffee beans. (Najiyati and Daniarti, 1997). The results of the pH test on Temanggung cold brew robusta coffee with variations in the level of the roasting process are presented in Figure 4.



Figure 4.. pH of Temanggung Robusta Coffee Cold Brew (Description: Light = temperature 210 °C and time 7 minutes. Medium = temperature 215°C and time 9 minutes. Dark = temperature 225°C and time 11 minutes)

Based on the graph in Figure 4. the results of the cold brew pH test of Temanggung Robusta coffee show that the average pH at the light roast level is 5.72, the medium roast level is 5.78, and the dark roast level is 5.96. The lowest average value is at the light roast level and the highest average value is at the dark roast level. The results of the analysis show that the higher the roasting level, the higher the pH of cold-brew coffee. During the roasting process, the acid content in coffee evaporates, so that the acidity value decreases. This finding is consistent with the views stated by Mulato (2002) and Poerwanty et al. (2020), who demonstrated that the total acidity of coffee decreases with elevated roasting temperatures.

Organoleptic of Temanggung robusta coffee cold brew

Sensory or organoleptic properties testing of Temanggung Robusta coffee cold brew was conducted by 30 panelists from various backgrounds, using a multiple comparison test with a 1-5 assessment scale comparing three samples of Temanggung robusta coffee cold brew with commercial excelso robusta coffee as a control. The assessment was carried out on Physicochemical And Organoleptic Characteristics Of Cold Brew Robusta Coffee (Coffea Canephora) From Temanggung Based On Roasting Process Shafa Nur Alifia Salsabila, Novian Wely Asmoro *, Agustina Intan Niken Tari

parameters of Flavor, Bitterness, Aroma, Color, and Overall (Table 1).

1. Flavor

The flavor of coffee is influenced by the degradation of a number of compounds, including carbohydrates, alkaloids, chlorogenic acid, volatile compounds and trigonelline. The temperature and duration of roasting affect the aroma of coffee. It has been demonstrated that the higher the temperature and the longer the roasting



Figure 5 Average . the organoleptic flavor test of Temanggung cold brew Robusta coffee



Figure 6. Average bitterness level of Temanggung robusta coffee cold brew



Figure 7. Average Aroma Rating of Temanggung Robusta Coffee Cold Brew

time, the more rapidly the compounds in the coffee will be heated, resulting in a change in taste from sour to bitter (Rahayu, 2023). The results of organoleptic tests on the characteristics of flavour in cold brew Temanggung robusta coffee with variations in the level of the roasting process based on flavour parameters are presented in Figure 5.

Based on Figure 5. the organoleptic flavor test of Temanggung robusta coffee cold brew obtained an average panelist score ranging from 2.9 to 3.3. Based on the graph in Figure 5, it shows that the organoleptic properties of flavor do not have a significant effect with a significance value (p>0.483) on the level of panelists' preference for Temanggung Robusta coffee cold brew. The dark roast level with the highest average value of 3.3 (quite tasty from R) shows the most preferred/tasty results. This shows that at the dark roast level, the flavor characteristics are not too different from the flavor of the commercial coffee control used.

2. Bitterness

The dominant bitter taste in coffee comes from the trigonelline compound found in coffee beans. In addition to the trigonelline compound, caffeine also influences the formation of a bitter taste in coffee, but in small amounts (Mustika, 2018). The results of organoleptic tests on the characteristics of the bitter taste in Temanggung cold brew robusta coffee with variations in the level of roasting process are presented in Figure 6.

Based on the graph in Figure 6, it can be shown that the organoleptic characteristics of bitterness do not significantly affect the panelists' preference for Temanggung robusta coffee cold brew. The dark roast level with the highest average score of 3.2 (sufficient of R) shows results that have a more bitter taste characteristic compared to the control. And the medium and light roast levels have the lowest average values of 2.9 (close to R) with a non-bitter taste characteristic compared to the control. The appearance of this bitter taste is also influenced by the caffeine content of the coffee.

3. Aroma

Aroma is a smell caused by chemical stimuli that are smelled by the alkatorial nerves in the nasal cavity when food enters the mouth (Fitriyono, 2014). The results of organoleptic tests on the aroma characteristics of Temanggung robusta coffee cold brew with variations in the level of roasting process are presented in Figure 7.

In Figure 7, the results of the organoleptic aroma test on Temanggung Robusta coffee cold brew obtained an average panelist score ranging from 2.5 to 3.3. Based on the graph in Figure 7, shows that the organoleptic properties of aroma have a significant effect on panelists' preference for Temanggung Robusta coffee cold brew. The dark roast level with an average value of 3.3 (quite sharp from R) shows the results that have the sharpest aroma characteristics and the roast level with the lowest average value of 2.5 (not sharp enough from R) is at the light roast level. Differences in roasting may



Based on Figure 8. the results of the organoleptic color test on Temanggung Robusta coffee cold brew obtained an average panelist score ranging from 2-4. Based on the graph in Figure 8, shows that the organoleptic properties of color have a significant effect on the panelists' assessment of Temanggung Robusta coffee cold brew. The light roast level with the highest average value of 4 (quite bright from R) and the medium roast level with the lowest average value of 2 (not bright from R). This is in line with research (Agustina et al., 2017) which states that the longer the roasting time affects the brightness level of the coffee to become darker. This causes the comparison of the brightness level at the light level with the control used to be brighter and the medium and dark levels look darker than the control (R).

5. Overall

Overall is the overall general acceptance of a product related to the level of liking and not measuring acceptance of certain sensory properties that aim to determine whether the product is acceptable or not (Soekarto, 1985). Acceptance of cold brew robusta coffee Temanggung with three different roasting levels was produced based on panelist assessments of flavor, bitterness, aroma, and color.



Figure 8. Average color assessment of Temanggung robusta coffee cold brew

affect the intensity of the aroma but are not significant. The dark roast level to sharper aroma characteristics, based on the results of the aroma test, it was shown that dark roasting had a sharper aroma level compared to commercial coffee as a control (R).

4. Color

Coffee color plays an important role in acceptance and appeal, acceptance of product quality to consumers, color is assessed through the eye organ which is called the visual way (Mulato, 2002). The results of organoleptic tests on the color characteristics of Temanggung Robusta coffee cold brew with variations in the roasting process level are presented in Figure 8. **Figure 9**. Overall acceptance of cold brew robusta coffee from Temanggung

The results of organoleptic tests on the overall characteristics of cold brew robusta coffee Temanggung with variations in roasting process levels are presented in Figure 9.

Based on Figure 9. the results of the overall organoleptic test on Temanggung robusta coffee cold brew obtained an average panelist score ranging from 3-3.5. Based on the graph in Figure 9. shows that the panelist's preference value does not have a significant effect on Temanggung robusta coffee cold brew. The

dark roast level with the highest average value of 3.5 (accepted from R) and the light roast level with the lowest average value of 3 (the same as R). The dark roast level is most accepted by the panelists because seen from the average assessment figures for flavor, bitterness, aroma, and color it is also the most superior. This is because the profile of the control (R) used has almost the same characteristics as the dark roast level.

Conclusion

Based on the results of the study, shows that the roasting process affects the caffeine and pH levels in Temanggung robusta coffee cold brew, with the highest caffeine levels at the dark roast level of 735.87 mg/L and the lowest at the light level of 489.18 mg/L. The pH value is also the highest at the dark level of 5.96 and the lowest at the light level of 5.72. The Temanggung robusta coffee cold brew with dark roast level was the most preferred by the panelists, based on the average rating of taste, bitterness, aroma and color, it had a higher value compared to the light roast, medium roast and control (R).

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