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Study of The Temperature and Timing Roasting of Black Glutinous Rice and Robusta Beans on The Quality of Coffee Powder

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Abstract

Coffee is a kind of drink that comes from the processing and extraction of coffee beans. In the production of coffee powder, the flavor is the essential quality because flavor affects consumer preferences. To produce a coffee drink that has a distinctive flavour, that is by combining robusta coffee beans and black glutinous rice. The purpose of this study was to determine the best treatment combination of temperature and roasting time of robusta coffee beans and black glutinous rice on the quality of the coffee powder. The research design used RAK which was arranged in a factorial manner of two factors, namely roasting temperatures of 190°C, 200°C, 210°C, and roasting times of 10, 15, and 20 minutes, to obtain 9 treatment combinations, 3 replicates. The research data were analyzed statistically by the ANOVA test, followed by the BNJ test. While the hedonic quality test is analyzed using the Friedman method. The Effectiveness Index test does determination of the best treatment. The best quality of coffee powder is produced at a temperature and roasting time of 200°C 20 minutes, namely the yield of 8.40%, the water content of 1.39%, ash content of 3.80%, the caffeine content of 1.33%, total antioxidants 71.87%, organoleptic characteristics, namely flavor 3.73 (strong), acidity 3.40 (quite sour), body/mouthfeel 3.67 (thick) and color 3.53 (black).

Keywords: Black Glutinous Rice, Coffee Powder, Robusta Coffee Beans, Caffeine in coffee, Total antioxidants in coffee

Key Messages:

- The higher the roasting temperature and time, the lower the total antioxidants of black glutinous rice coffee
- The higher the roasting temperature and time, the higher the caffeine content of black glutinous rice coffee

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1. Introduction

Coffee is a type of beverage that comes from the processing and extraction of coffee beans. The culture of drinking coffee today is a new trend that has emerged in various circles of society. In this case, the culture of coffee consumption is usually carried out by people in cafes and coffee shops in big cities and small towns (1). In the

production of coffee powder, the flavor is the most important quality because flavor affects consumer preferences. Flavor will be formed during the coffee production process, especially during roasting. According to (2) the roasting process is the stage of forming the distinctive flavor and taste of coffee from the coffee beans by heat treatment (3). Robusta coffee is the most widely produced type of coffee in Indonesia than other types of coffee. Type Robusta coffee dominates Indonesian coffee production, which is 81.87% of the total coffee bean production in 2016, while the remaining 18.13% is Arabica coffee (4). Robusta coffee has a taste that tends to be more bitter and an flavor that is not liked by consumers, compared to Arabica coffee which tends to be liked (5). So that when processing robusta coffee, it is necessary to innovate the addition of other ingredients such as black sticky rice to add a distinctive flavor and taste to robusta coffee powder. A breakthrough to produce coffee drinks that have a distinctive taste and flavor is by combining robusta coffee beans and black glutinous rice. Sticky rice contains sugars such as glucose and galactose, if these ingredients are roasted, it will produce a sweet taste and fragrant flavor (6). Black sticky rice contains carbohydrates which are high enough so that when roasted it will cause a distinctive flavor (7).

The purpose of this study was to determine the best treatment combination of temperature and roasting time of robusta coffee beans and black glutinous rice on the quality of coffee powder.

2. Methods

This research was conducted at the Food Design and Food Chemistry Laboratory, Food Science and Technology Study Program, Faculty of Agriculture, Tanjungpura University, Pontianak, for approximately 6 months. The ingredients used are black glutinous rice, and robusta coffee beans (green beans), the chemicals used are distilled water, methanol, KOH solution, H2SO4, and DPPH. The tools used in this research include an electric roaster, an electric grinder, and a 40-mesh sieve to get the desired coffee powder. The tools used for analysis include analytical scales, porcelain dishes, desiccators, furnaces, test tubes, test tube racks, suction flasks, volume pipettes, beakers, spectrophotometry, Erlenmeyer, a set of soxhlet, oven, kiln. The tools used for sensory testing are coffee cups, label paper, tasting booths, and stationery.

The process of making black glutinous rice coffee begins with the preparation of 80% coffee beans and 20% black sticky rice preparation, after that the roasting machine is heated, then the roasting is carried out according to a predetermined temperature and time, and the roasted coffee beans are cooled, then ground using a machine. electric grinder, and sieved using a 40-mesh sieve, black glutinous rice coffee is ready for analysis.

The research design used a Randomized Block Design (RAK) which was factored into two factors, namely roasting temperature (P) and roasting time (W). Based on these two factors, 9 combinations were obtained, 3 replicates. Factors of treatment carried out include: A) Factor I Temperature: p1 = 190°C, p2 = 200°C, p3 = 210°C. B) Factor II Time: w1 = 10 Minutes, w2 = 15 Minutes, w3 = 20 Minutes;

Organoleptic testing has an important role in the application of quality. Organoleptic testing is referred to as assessment with the senses or sensory assessment that utilizes the five human senses. There are five types of sensory modalities, namely sight, smell, touch, hearing, and taste. the purpose of organoleptic testing is to find out whether a particular commodity or sensory trait can be usedaccepted by society (8). Organoleptic quality is product quality that can only be regulated or assessed by a sensing process which includes color, *flavor*, taste, and texture. The organoleptic test in this study using the hedonic quality test method was carried out with the aim of knowing the value of *flavor* quality, acidity, body/ mouthfeel, color and preference of black glutinous rice coffee. For quality assessment or analysis of sensory properties of a commodity, panelists act as instruments or tools. The test was carried out by 30 semi-trained panelists.

The research data were analyzed statistically with the F test (ANOVA) with a test level of 5%, if it had a significant effect, then it was continued with the Honest Significant Difference (BNJ) test with a level of 5%. While the quality test hedonic analysis uses the Friedman method. Determination of the best treatment is done by comparing the value of each treatment through the Effectiveness Index test using the method (9).

3. Results

The results of the study in Tables 1 and 2 show that the roasting temperature and time have a significant effect on the yield of black glutinous rice coffee produced. The highest yield value of black glutinous rice coffee with respect to temperature was found in the treatment 190^{o}C which is 87.38%, while the lowest yield is found in the temperature treatment 210^{o}C that is 84.71%. The highest yield value of black glutinous rice coffee was found in the time treatment10 minutes which is 87.46%, while the yield the lowest is in the treatment time 20 minutes

that is 84.58%. The results of the study Tables 1 and 2 show that the roasting temperature and time significantly affect the water content of the black glutinous rice coffee produced. The value of the highest water content of black glutinous rice coffee to temperature is found in the treatment 190°C which is 2.02%, while the lowest water content is in the temperature treatment 210°C ie 1.45%. The highest water content value of black glutinous rice coffee with respect to time is found in the time treatment 10 minutes which is 2.01%, while the lowest water content is found in the treatment time 20 minutes ie 1.47%.

The results of the study Tables 1 and 2 show that the temperature and roasting time had no significant effect on the ash content of the black glutinous rice coffee produced. The value of the highest ash content of black glutinous rice coffee with respect to temperature is found in the temperature treatment of 190°C which is 3.67%, while the lowest ash content is in the temperature treatment 210°C ie 3.82%. The highest ash content of black glutinous rice coffee with respect to time was found in the temperature treatment 10 minutes which is 3.69%, while the lowest ash content is in the temperature treatment 20 minutesie 3.80%.

The results of the study in Tables 1 and 2 show that the roasting temperature and time have a significant effect on the caffeine content of the black glutinous rice coffee produced. The value of the highest caffeine content in black glutinous rice coffee is at a temperature of 210°C which is 1.37%, while the lowest water content is in the temperature treatment 190°C ie 0.82%. The value of the highest caffeine content of black glutinous rice coffee against time was found in the temperature treatment 20 minuteswhich is 1.28%, while the lowest caffeine content is in the temperature treatment 10 minutes ie 0.90%.

Table 1. Results of Analysis of Yield, Moisture Content, Ash Content, Caffeine Content, and Total Antioxidants Against Temperature

Temperature	Yield (%)± SD	Water content (%)± SD	Ash Content (%)± SD	Caffeine Level (%)± SD	Total Antioxidant (%)± SD
190°C	87.38^{c} ± 3.73	2.02^{c} ±0.57	3.67 ± 0.35	0.82^{a} ± 0.48	76.59^{c} ± 8.48
200°C	85.62^{b} ± 3.86	1.71^{b} ± 0.97	3.77 ± 0.09	1.12^{b} ± 0.77	75.10^{b} ± 8.82
210°C	84.71^{a} ± 5.49	1.45^{a} ± 0.91	3.82 ± 0.06	1.37^{c} ± 0.51	72.01^{a} ± 9.06

Table 2. Results of Analysis of Yield, Moisture Content, Ash Content, Caffeine Content, and Total Antioxidants Against Time

Time	Yield (%)± SD	Water content (%)± SD	Ash Content (%)± SD	Caffeine Level (%)± SD	Total Antioxidant (%)± SD
10 minutes	87.46^{c} ± 3.26	2.01^{c} ± 0.65	3.69 ± 0.43	0.90^{a} ± 0.81	76.89^{b} ± 7.28
10 minutes	85.68^{b} ± 4.32	1.70^{b} ± 0.92	3.77 ± 0.14	1.14^{b} ± 0.85	75.52^{b} ± 6.30
10 minutes	84.58^{a} ± 4.72	1.47^{a} ± 1.00	3.80 ± 0.15	1.28^{c} ± 0.84	71.29^{a} ± 7.45

Table 3. Hedonic Quality Test Results for Black Glutinous Rice Coffee

Temperature and Time	Average				
	flavor ± SD	Acidity ± SD	*Body/ mouthfeel* ± SD	Color ± SD	Favorite ± SD
190°C 10 Min	2.50±0.51	3.70±0.65	2.43±0.57	2.60±0.50	2.27±0.45
190°C 15 Min	2.73±0.58	3.47±0.51	2.47±0.51	2.80±0.66	2.63±0.56
190°C 20 Min	3.07±0.45	3.47±0.73	2.90±0.55	2.90±0.61	2.83±0.59
200°C 10 Min	3.30±0.47	2.83±0.53	2.87±0.57	2.97±0.41	3.07±0.58
200°C 15 Min	3.50±0.51	3.13±0.51	3.20±0.55	3.13±0.57	3.27±0.58
200°C 20 Min	3.73±0.45	3.40±0.62	3.67±0.66	3.53±0.51	3.90±0.48
210°C 10 Min	3.67±0.48	2.97±0.56	3.30±0.60	3.50±0.57	3.70±0.65
210°C 15 Min	3.67±0.48	2.77±0.57	3.07±0.69	3.57±0.50	3.73±0.52
210°C 20 Min	3.87±0.51	2.53±0.51	4.27±0.64	3.87±0.43	4.00±0.53
asymp. Sig.	0	0	0	0	0

Description: Asymp. Sig < 0.05 then it has a significant effect.

The results of the study Tables 1 and 2 show that the roasting temperature and time have a significant effect on the total antioxidants of black glutinous rice coffee produced. Score total antioxidants the highest black glutinous rice coffee with respect to temperature is found in the temperature treatment 190^{o}C which is 76.59%, while the lowest total antioxidant is found in the temperature treatment 210^{o}C that is 72.01%. The highest total antioxidant value of black glutinous rice coffee with respect to time was found in the treatment 10 minutes that is 76.89%, while the lowest total antioxidant is found in the treatment time 20 minutes namely 71.29%. Table 3. Shows that the Asymp value. Sig < 0.05 so that it can be seen that the acidity in steeping black glutinous rice coffee has a significant effect on the temperature and roasting time.

4. Discussion

Yield

Yield is an important value in product manufacture, rendement is expressed as a percentage of the weight of the final product produced per weight of processed material (10). The results of the BNJ test showed that the higher the temperature and the longer the roasting time, the lower the yield of black glutinous rice coffee. It is suspected that there is greater evaporation of water during the roasting process of black sticky rice and robusta coffee beans, the hotter the temperature, the wider the surface of the coffee and black sticky rice so that the water is free to evaporate easily. The ability of the material to release free water from its surface will be greater with increasing air temperature used, so that the resulting yield is lower (11). The shrinkage value is highly dependent on temperature and roasting time. The longer the roasting process and the higher the temperature used, the higher the shrinkage(12).

Water content

Water content is one of the factors that affect the durability of a product, the lower the water content of the product will extend the shelf life of a material, on the contrary if the dried material is not too dry, the shelf life will be lower (13). The results of the BNJ test showed that the higher the roasting temperature and time, the lower the water content of black glutinous rice coffee. It is suspected that during the roasting process there is evaporation of water from the ingredients into the air which can reduce the water content in black glutinous rice coffee. The temperature and roasting time greatly affect the water content (14). The higher the temperature and the roasting time, the more water content in the evaporated material. The higher the temperature and the roasting time, the lower the water content will be (15). The greater the temperature difference between the heating medium and the food, the faster the heat transfers to the food and the faster the evaporation of water from the food (16).

Ash Level

Ash content is an inorganic substance left over from the combustion of a food ingredient. Ash content and its composition depend on the type of material and the method of ashing. Most of the food ingredients, which is about 96% consists of organic matter and water. In this study, the ash content of 3.53%-3.84% had no significant effect. Ash content is the amount of minerals contained in the material, while the minerals contained in coffee include potassium, magnesium, phosphorus and sulfur (17). Determination of ash content is closely related to the mineral content contained in a material, the purity and cleanliness of the resulting material (18). Ash content is a mineral component that does not evaporate in the combustion process or annealing organic compounds. Aan increase in temperature and appropriate time in a roasting process does not result in mineral damage (19).

Caffeine Level

Caffeine is one of the alkaloid compounds naturally found in coffee beans which acts as a refreshing ingredient and non-alcoholic stimulant compound that is crystalline, tastes bitter and easily dissolves in water (20). The lower the caffeine content, the lower the bitterness value in brewing coffee. The results of the BNJ test showed that the higher the roasting temperature and time, the higher the caffeine content of black glutinous rice coffee. Allegedly due to the decomposition of liquids and acids so that caffeine levels increase. The higher the roasting temperature, the caffeine content will also increase, caused by the decomposition of liquids (H_2O) and

acids so that the percentage of non-liquid substances such as caffeine, fat and minerals increases. The higher the roasting temperature, the caffeine content in the ingredients will also increase, because the reduced liquid content will increase the amount of non-liquid substances such as caffeine and fat (21).

Total Antioxidant

Antioxidants are substances that can neutralize free radicals so that they can protect the body's biological systems from harmful effects arising from processes or reactions that cause excessive oxidation (22–25). The results of the BNJ test showed that the higher the roasting temperature and time, the lower the total antioxidants of black glutinous rice coffee. It is suspected that the roasting process can reduce total antioxidants due to the degradation of polyphenols in robusta coffee and flavonoids in black glutinous rice. The longer the roasting time, the lower the antioxidant capacity, this condition is due to the loss of some polyphenol compounds as a result of the oxidation reaction during roasting (26). Flavonoid compounds are not heat resistant and easily oxidized at high temperatures (27). The higher the temperature and the roasting time, the lower the total antioxidants produced (28). The decrease in total antioxidants in black glutinous rice can occur because it is influenced by several factors including light, oxygen, and temperature (29).

Flavor

Flavor is a quality trait that quickly gives an impression to consumers, because *flavor* is a very influential factor on consumer acceptance of a product (30). Based on the results of the organoleptic test of black glutinous rice coffee, the lowest value is found at a temperature of 190°C 10 Minutes is 2.50 (not strong), while the highest value is intemperature 210°C 20 Minutes which is 3.87 (strong). Friedman test results Table 3. Shows that the Asymp value. Sig < 0.05 so that it can be seen that the *flavor* of steeping black glutinous rice coffee has a significant effect on temperature and roasting time. The higher the temperature and the longer the roasting time, the stronger the distinctive *flavor* of black glutinous rice coffee. It is suspected that the phenolic and volatile compounds present in coffee beans and black glutinous rice will come out to form an *flavor* when the maillard and caramelization reactions occur. The *flavor* of coffee arises as a result of volatile compounds caught by the human sense of smell, volatile compounds that affect the *flavor* of roasted coffee are formed from Maillard reactions or non-enzymatic browning reactions, sugar degradation and degradation of phenolic compounds, the longer the roasting time. the more volatile compounds that evaporate so that it will affect the *flavor* of ground coffee (31).

Acidity

Every coffee product contains acids that will affect the degree of acidity, *flavor* and taste of the coffee product. Types of carboxylic acids in coffee beans include acetic acid, formic acid, lactic acid, malic acid, pyruvic acid, quinic acid and citric acid (3). Based on the results of the organoleptic test of black glutinous rice coffee, the highest value was found at a temperature of 190°C 10 Minutes is 3.70 (acidic) while the lowest value is attemperature 210°C 20 Minutes is 2.53 (not acidic). Friedman test results. The higher the temperature and the longer the roasting time, the acidity of the black glutinous rice coffee will decrease. It is suspected that the decrease in acidity is caused by the evaporation of acid in the coffee beans and black glutinous rice. This decrease in acidity value is due to the evaporation of chlorogenic acid and carboxylic acid when coffee is roasted (32).

Body/ Mouthfeel

Body/mouthfeel is a sensation received by the sense of taste in the form of a thick, soft or smooth taste. The texture of coffee is related to the density and viscosity in coffee which is often referred to as the body. In the mouth, the body is often described as smooth and thick coffee felt by the surface of the tongue. The thicker the coffee produced, the higher the value produced (33). Based on the organoleptic results of black glutinous rice coffee, the highest value was found at a temperature of 210°C 20 Minutes is 4.27 (very thick), while the lowest value is attemperature 190°C 10 Minutes which is 2.43 (not viscous). Friedman test results Table 3. Shows that the Asymp value. Sig < 0.05 so it can be known *Body/ mouthfeel*in steeping black glutinous rice coffee has a significant effect on the temperature and roasting time.

The higher the temperature and the longer the roasting time, the*Body* of black glutinous rice coffee will increase. It is suspected that lipid compounds during the pyrolysis process are broken down to produce oil in

coffee beans, and the amylopectin content in black glutinous rice causes *Body* black glutinous rice coffee is getting higher. The breakdown of high lipid compounds will produce more coffee oil and affect the viscosity of coffee (34). Amylopectin was broken down into Gelatinization occurs at hot temperatures which results in viscosity of the solution (13).

Color

Color is a parameter that can be tested directly by the panelists' sense of sight (35). Based on the results of the organoleptic test of black glutinous rice coffee, the highest value was found at a temperature of 210°C 20 Minutes is 3.87 (black), while the lowest value is attemperature 190°C 10 Min ie 2.60 (not black). Friedman test results Table 3. Shows that the Asymp value. Sig < 0.05 so that it can be seen that the *flavor* of steeping black glutinous rice coffee has a significant effect on temperature and roasting time. The higher the temperature and the longer the roasting time, the darker the color of the black glutinous rice coffee will be. Allegedly because the carbohydrate content, sugar in coffee beans and black sticky rice are caramelized which causes the color of the coffee to become darker. Another factor that affects the color of the brewed coffee produced, namely because of the caramelization process of sugar which causes a dark brown color (36).

Favorite

Based on the results of the organoleptic test of black glutinous rice coffee, the highest value was found at a temperature of 210°C 20 Minutes is 4.00 (like), while the lowest value is intemperature 190°C 10 Minutes which is 2.27 (dislike). Friedman test results Table 3. Shows that the Asymp value. Sig < 0.05 so that it can be seen that the preference for steeping black glutinous rice coffee has a significant effect on temperature and roasting time. Panelists prefer coffee with roasting temperature 210°C 20 Minutes with a strong *flavor* character, less acidic, very thick body, black color. While the roasting temperature of 190°C for 10 minutes, the panelists did not like it because at that temperature the coffee still tends to be less flavorful, less acidic, less thick, and less black.

5. Conclusion

Based on the results of this study, it can be concluded that the temperature and roasting time of robusta coffee beans and black glutinous rice significantly affect the yield, water content, caffeine content, total antioxidants, *flavor*, acidity, body/mouthfeel, color, and preference. Black glutinous rice coffee processing produces the best quality coffee at a temperature and roasting time of 200°C 20 minutes. The quality of the coffee produced is 84.40% yield, 1.39% water content, 3.80% ash content, 1.33% caffeine content, 71.87% total antioxidant, organoleptic characteristics, namely 3.73 *flavor* (strong), acidity (acidity) 3.40 (sufficiently acidic), *body/mouthfeel* 3.67 (thick) and color 3.53 (black), favorite 3.90 (like).

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